Iron and Steel Engineer

Established 1907 as Proceedings of A. I. & S. E. E.

JOHN F. KELLY, EDITOR

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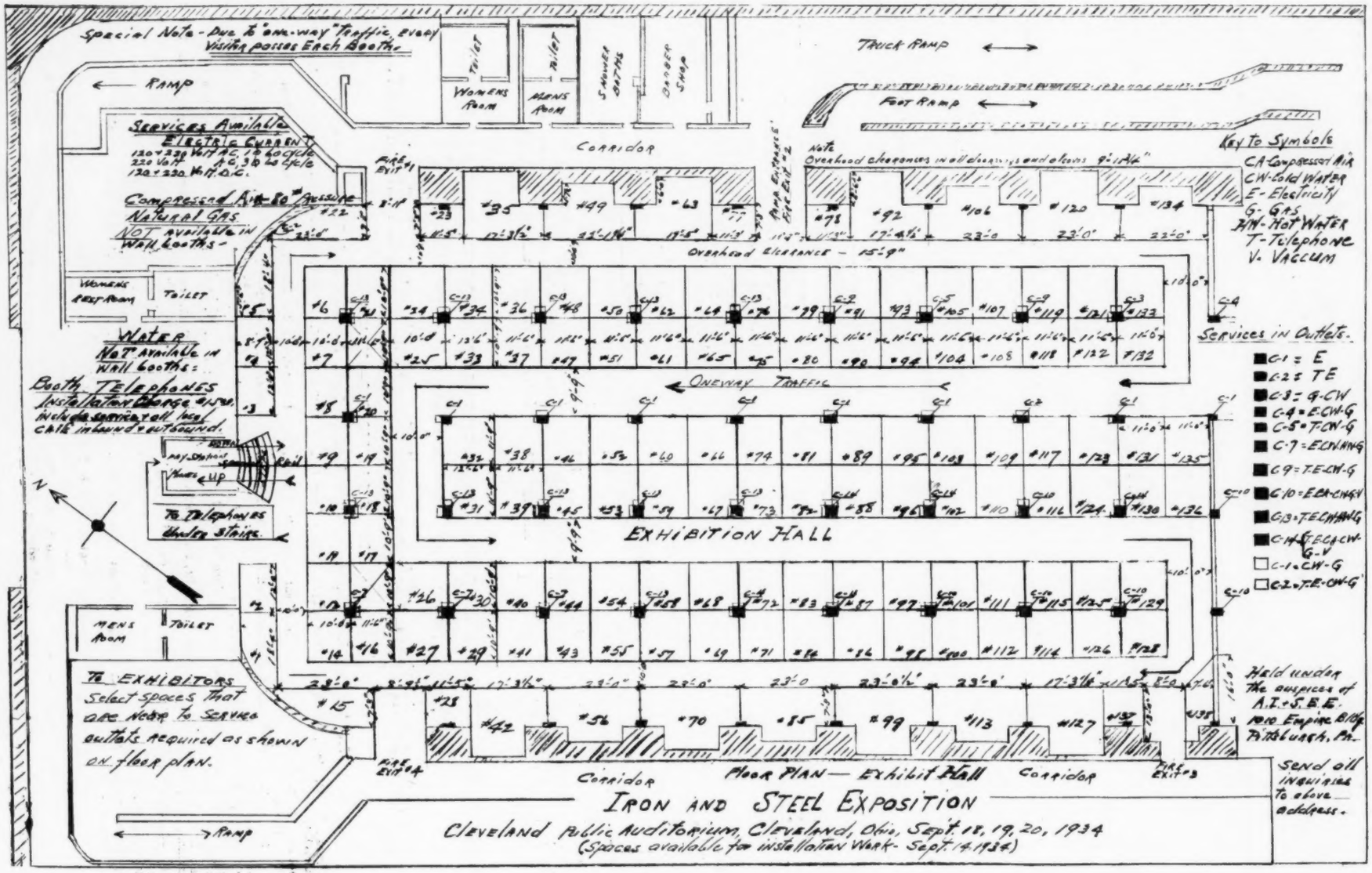
IRON AND STEEL EXPOSITION

CLEVELAND, OHIO, SEPTEMBER 18, 19, 20, 1934



Floor plan of the Iron and Steel Exposition to be held under the auspices of the Electrical, Mechanical, Lubrication, Welding, Combustion and Safety Engineering Divisions of the Association of Iron and Steel Electrical Engineers, Cleveland, Ohio, September 18, 19, 20, 1934. An exposition of the developments in apparatus and equipment to process and produce Iron and Steel.

EDITORIAL

Research of Today

Taking the liberty of quoting from Mr. Frank Purnell's letter of welcome to the Association of Iron and Steel Electrical Engineers upon the occasion of the Annual Spring Engineering Conference of the Association being held in Youngstown, April 11th and 12th, we find Mr. Purnell saying that, "Upon your research of today will depend the methods and products of tomorrow." Quoting still further from his letter he says, "People who know steel realize the contributions which engineering and research have made to the advance of industry. They know that today's great mills and smoothly functioning processes have been made possible largely through years of scientific study and experimentation."

This recognition of the value of research and engineering conferences, as expressed by Mr. Purnell with such clarity, is stimulating to the membership of the A. I. & S. E. E. It demonstrates conclusively that the scientific way of approaching a problem is by assembling a group of minds instead of individually seeking a solution. This mutual way of studying a problem gives functions like the Spring Engineering Conference the air of a laboratory. Under the microscopic-like eyes of hundreds of steel mill engineers, gathered in one place, there is little opportunity for an engineering problem to escape at least partial analysis.

While successful analysis of every problem is impossible at meetings of this nature, the bringing out into the open of a particularly difficult problem puts it into a position where the knowledge of many may be utilized in disposing of it. The gratifying results which have been secured in using methods like these to help make the Steel Industry what it is today, makes the Association of Iron and Steel Electrical Engineers hope, that through this "Research of Today," there shall evolve a still greater industry.

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Welding and The Steel Industry

By A. E. GIBSON
Vice President, The Wellman Engineering Co.,
Cleveland, Ohio

Presented before the Welding Engineering Division of the A. I. & S. E. E. at the Annual Convention in Pittsburgh, October 19,1933.

No subject in your entire convention program is of more vital importance to the steel industry than welding. This fact has been recognized by your program committee in devoting one-third of your entire program to this subject.

I have a great interest in the welfare of the steel industry as a whole. Our company, since its inception, has been very intimately associated with your industry; its organization was based upon the fact that the steel industry in America offered a fertile field to a forward looking engineering organization with the ability to present new methods and new equipment for the advancement of the making of iron and steel and its allied products.

A. E. GIBSON

Many of you know that the late Mr. S. T. Wellman, an eminent American engineer of 30 years ago, and the founder of our company, built one of the first commercially successful open hearth furnaces in America for the Bay State Steel Company of Boston. Mr. Wellman's work in the early development of the stationary and tilting open hearth was a great contribution to the advancement of the art. His conception and building of the open hearth charging machine, which he patented in 1888, has probably had a more revolutionary effect on the production of steel than any other piece of mechanical equipment since devised.

Our development in rolling mills, chargers, manipulators, bridges, ore loaders, car dumpers, gas producers, skip and mine hoists, coke oven machinery, and other mechanisms, brought new and labor saving equipment into every steel plant in America and into every civilized country in the world.

Those of us whose privilege it is to carry on the work so ably begun by Mr. Wellman and his earlier associates, are proud of our company's record. We are constantly striving, even in these most difficult times, to bring to you new methods and equipment which will aid you in your efforts to make better and cheaper steel.

And so it is natural that we should be keenly interested in the welfare of the steel industry. Without you we would cease to exist; when you are prosperous, we are prosperous; when your industry is depressed, it is quickly reflected in our production.

This is one of the chief reasons we are interested in this very live subject of welding; this is the reason we are anxious that you should put your shoulder behind the development of welding and give to it the impetus that only you can give.

It has been a mystery to me why the steel industry as a whole has quietly stood on the side lines for so many years and left to the equipment and supply manufacturers the problem of the advancement of the art of welding. The potential market for your product, in the development of welded mechanical equipment, is so vast that the total possible revenue to welding equipment manufacturers is small in comparison.

I am not particularly interested in the subject of welding as a means of replacing riveting; it has little to offer either to you or to us in that field, but I am intensely interested in the fabrication of mechanical equipment by welding. In past years most of us have looked at welding as a means of making simple mechanical details where shapes and plates could be used with little preparatory labor. During the last few years we have found that the use of welding is almost limitless in making details light in weight and still competitive in price with castings. All of you are familiar with the extent to which the electrical companies have gone in the manufacture of welded motors and brakes. We have found it profitable to make even much smaller and lighter and more intricate equipment by welding. It would surprise to know the extent to which we have carried welding in mechanical details; it would be equally surprising to know the tonnage of castings we have replaced by welded steel. Every piece of equipment we make with a welder means increased tonnage for you, and means increased hours of labor in your mills and in our own shop instead of this tonnage and hours going into some outside foundry in which neither you nor we have any interest.

Our first venture into the substitution of welding for castings was many years ago and was prompted by our efforts to find a way out of the trouble we were constantly confronted with in the failure of steel castings to withstand a high temperature on one side, water cooling on the other and strains both from expansion and external sources.

This experiment, the making of a 12-ft. diameter mechanical gas producer top plate, was a success from the start. From this beginning we have gradually increased the building of welded parts until today in our drawing room it is not a question of "is it feasible to make it welded", but a question of "why make it casting".

Top—Fly wheel 121" Dia. x 18" face all-welded construction

Bottom—Welded hauling-in winch-housing for telescopic mooring mast.

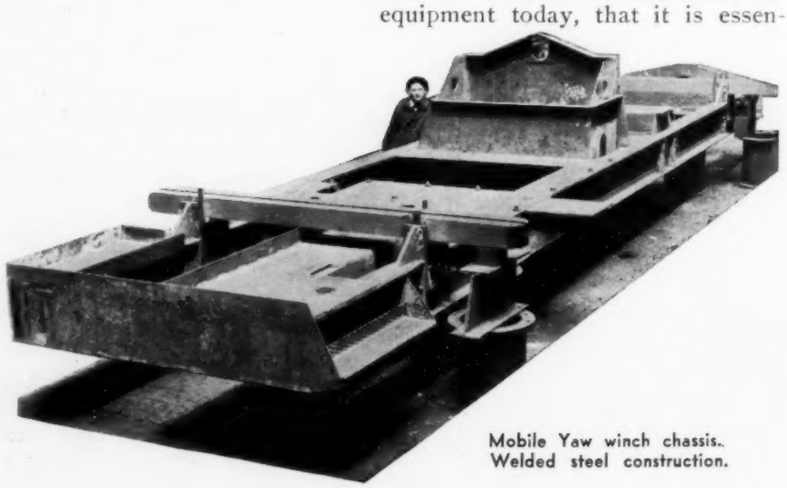
This progress has not been rapid, but the result of a rather tedious educational program. It was unfortunate that the first use of the electric arc was as a maintenance tool in the shop and for years what progress was made was at the request and instigation of the production men. We are now organized to carry on our welding design as we carry on other lines of engineering work through our draftsmen and engineers.

It is true that several steel companies, notably Lukens and Carnegie at Homestead, have been among the leaders, but the vast steel industry as a whole has been backward in the adoption of welding.

Within the past few months I called on one of the chief executives of the steel industry, and expressed my regret that his company has not taken a more active interest in cultivating this vast potential market. This gentleman told me that they now realized the possibilities and had taken steps to energetically promote the increased use of welded mechanical equipment. I told him I knew what his company was doing in research, investigation, and advertising, but unless they took steps to educate their own engineering and operating departments, their progress would be slow. I cited the case, without giving names, of a recent instance where the engineer in one of their plants had reluctantly agreed that certain bed plates be changed from cast iron to welded steel, provided the metal sections were not changed. I spoke of another plant chief engineer who refused to allow us to incorporate any welded mechanical details in a certain piece of equipment we were building for them. I ended the conversation with the statement that he himself had come up through the operating end and knew full well the almost insurmountable obstacle of forcing through any program in which the operating and engineering staffs had little faith.

This problem of education is making headway. With each new and successful piece of welded equipment put into operation, more operating men and engineers are being converted to its possibilities.

For you, as engineers, to be satisfied that welding is feasible; for you to agree, as I know you do, that welded motor frames and bed plates are satisfactory, is not enough. There is so close a tie between mechanical and electrical equipment today, that it is essen-



Mobile Yaw winch chassis. Welded steel construction.

tial that you know how far it is possible to go in the fabrication of mechanical equipment. It is essential that you know whether it is feasible to build welded gear reductions, welded gears, drums, and the hundreds of other details entering into the construction of mechanical equipment. It is essential that you write the specifications for equipment, or are responsible for its selection and operation know what is good welding practice and what is not; to know whether the work you buy is welded with bare or heavily coated wire, to know whether the particular piece in question should be heat treated to relieve welding strain or normalized to refine the grain structure, in order to secure the best possible physical results.

Today very little welding work carries with it specifications insuring the purchaser of satisfactory results. The questions of bare or coated wire, of positioning work in welding, of strain relief, of normalizing, of fillet weld sizes, are left to the shop performing the work. As a result, it is almost impossible for a conscientious organization engaged in doing quality work to compete with the ordinary jobbing weldery. For our part, we do not try to; we cannot employ experienced men who have had a long period of training in our works and on whom we have spent considerable time and money; we cannot carry on regular inspection and testing of our operator's work; we cannot stress relieve and normalize work in competition with concerns not working along the same safe lines.

The time will come, and very soon, when firms wishing to quote on steel mill equipment will have to satisfy a critical engineering and operating staff as to the quality of their work, the same as is required in the purchase of most other kinds of products now bought by your companies.

If there is one thought I could indelibly impress upon your mind so that you would carry it back and have it always before you, it is that no one line of effort can give you the expanded market equal to realizing the full possibilities of welded mechanical equipment. I don't expect you, gentlemen, all to become welding experts, but I do consider it your duty as steel mill engineers to know the possibilities of the art. I do expect that knowing these possibilities you will put your new equipment into welding wherever it is commercially sound to do so. With this knowledge and interest in welding I assure you that the attendant expansion in your tonnage will be startling in its scope.

▲

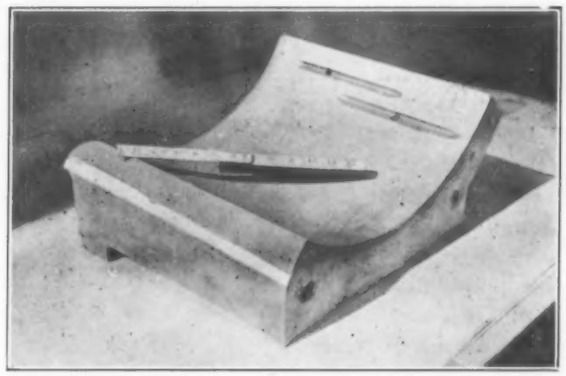
Aluminum Bearing Shells for Heat Dissipation

By B. C. McFADDEN,
Chief Mechanical Engineer,
Aluminum Company of America

For some time, rolling mill engineers have been giving the subject of roll neck bearing design a great deal of study. This study is divided into that of roller bearings, babbitt metal lined shells and simple bronze shells, as well as that of lubrication.

While lubrication is in itself a big problem, bearing shell design must be carried along with the lubrication problem in order to obtain the best results.

Owing to space limitation, it often happens that plain bearings cannot be made large enough to permit unit bearing pressures much higher than those generally considered allowable in machine design.



Photograph illustrating Aluminum Bearing Shell.

In many cases, the designer is forced to use bearing pressures which could not be considered in other types of machines. For high bearing pressures, one of two general types of bearings may be used. They may be either anti-friction bearings or plain bearings, designed in such a way that the heat can be carried away fast enough to prevent building up of temperature in the neck and body of the roll.

As every roller knows, if the heat flows from the roll neck to the roll body, the technique of rolling good sheet is much more complicated. Heat coming from the neck first causes the ends of the roll to expand. This condition tends to pinch the edges of the sheet, and the material leaving the mill will have considerable gauge variation from edge to edge.

Another effect of passage of heat from the roll neck to the roll body in a fixed bearing mill is the pinching of the roll at the fillet. This has been responsible for the breaking of rolls in many cases.

The tendency today is for higher production which tends to increase rather than decrease neck bearing pressure. The advent of hardened forged steel rolls has further increased the problem of maintaining satisfactory neck temperature conditions as steel necks are harder to lubricate than cast iron necks.

The heat in a roll neck bearing is largely the result of friction between the roll neck and the bearing surface, although some heat is caused by the impact which is present in certain classes of mills. The problem is to take away and dissipate the heat from the bearing as quickly as it is generated. This has been accomplished by the use of aluminum bearing shells.

With the development of aluminum alloys, it became possible to obtain either a wrought or cast aluminum bearing shell which will operate satisfactorily. In the wrought condition, these alloys have about the same tensile strength as machine steel. The casting alloy has average physical properties as follows:

Tensile Strength	—31,000 lbs. per sq, in.
Elongation in Two Inches	—8%
Compression Yield	—27,000 lbs. per sq. in.
Ultimate Compressive Strength	—43,000 lbs. per sq. in.

The main benefit of using aluminum is derived from its high heat conductivity in comparison with other available metals. In order to take the maximum advantage of this property, it is necessary to get the best possible bond between the aluminum shell and the bearing babbitt; this is accomplished by tinning the aluminum shell, before pouring the babbitt.

The aluminum shell is tinned by submerging it in a tin bath and thoroughly scratching the surface with a wire brush while it is submerged. This removes the oxide on the aluminum shell and the tin will then adhere to the surface. When the babbitt is poured, it alloys with the tinned surface, thereby effecting an excellent bond. Mechanical bond can be improved by dove-tailing the inner surface of the shell.

The tinning of the aluminum shell before babbitting produces a bond between the two metals which permits the maximum flow of heat through them. Since babbitt metals have a low heat conductivity, it is advantageous to make the babbitt lining as thin as is permissible. Another advantage in a thin wall of babbitt metal is its resistance to mechanical peening action.

Aluminum bearing shells with babbitt liners have been used by the Aluminum Company of America for more than two years. Their satisfactory service record has caused the Company to replace even the bearings in the newest mills. To date, the use of aluminum shells has been confined to bearing areas of 120° and less, but trials are to be made upon 180° half-bearings.

A set of strong alloy aluminum bearing shells with lead base babbitt liners, were installed in 1931 in a 26x60-in., 3-high cold strip, heavy duty mill, driven by a 750-hp. motor. During their two years of service, the bearings have been carefully watched and have conclusively demonstrated their adaptability for this type of service. At times the load on the mill has exceeded 1500 hp. and the total neck pressure on the rolls has been between 750,000 and 1,000,000 lbs. As the necks of these rolls are 20 in. in diameter and 18 in. in length, the unit pressure has probably exceeded 4500 lbs, per sq. in.

A 26x60-in., 2-high cold strip finishing mill was equipped with water cooled aluminum shells with babbitt metal liners. The load on the bearings in this mill is not as great as on the roughing mill, but it is of longer duration and its forged steel rolls are more sensitive to temperature changes on account of their higher coefficient of expansion affecting the roll shape. Since the installation of aluminum bearing shells approximately 18 months ago on this mill, the troubles with the roll shapes have been completely overcome.

The use of aluminum bearing shells can be described best by giving their service record on two heavy duty mills. The first hot mill to be equipped with aluminum bearing shells was a 28x84-in., 3-high mill driven by a 1000-hp. D.C. motor. The load on the bearings for this mill is ordinarily of shorter duration than that on the bearings of the cold break down strip mill; but the bearings in this case are subjected to far greater shocks than are normally present in a cold mill. Since water cooled aluminum shells, poured with soft metal liners, were installed a little over a year ago, the trouble due to hot bearings, which followed roll or bearing change, has been minimized by the higher conductivity of the aluminum shells, and a change in the bearing metal. This has increased the available production time on this mill as well as affecting the power consumed in rolling.

The success of aluminum bearing shells on this mill led to their adoption on a 32x84-in., 3-high hot mill which was driven by a 2000-hp., D.C. motor. The routine rolling of strong alloy aluminum ingots calls for peak loads approaching 6,000 hp. with total screw pressures in excess of 2,000,000 lbs. The necks of the rolls in this mill are 23 in. in diameter by 21 in. in length, and since only a partial bearing is used, the unit pressure is about 5,000 lbs. per sq. in. Aluminum bearing shells have now been used in this mill for approximately six months and have given satisfactory service.

OFFICIAL PROGRAM
SPRING ENGINEERING CONFERENCE
ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

Auspices

COMBUSTION ENGINEERING DIVISION

OHIO HOTEL — **APRIL 11th and 12th, 1934** — **YOUNGSTOWN, OHIO**

General Chairman
F. E. LEAHY, Fuel Engr.,
Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

General Secretary
J. L. MILLER, Asst Chief Engr.,
Carnegie Steel Company,
Youngstown, Ohio.

WEDNESDAY EVENING, APRIL 11th

7:30 P. M.

"Temperature Distribution in Electric Furnaces compared to Fuel Fired Furnaces" by W. Scott, Special Repr., Westinghouse Elec. & Mfg. Co., Mansfield, Ohio.

8:00 P. M.

"Use of Electric Furnaces for Box Annealing" by A. N. Otis, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

8:30 P. M.

"Utilization of Batch Furnaces for Heating" by T. B. Bechtel and M. H. Mawhinney, The Electric Furnace Co., Salem, Ohio.

9:00 P. M.

Discussion: Papers of Messrs. Scott, Otis, Bechtel and Mawhinney.

THURSDAY (All Day) APRIL 12th

9:00 A. M.

Registration, Chairman C. A. Thayer, Chief Engineer, Republic Steel Corporation, Youngstown, Ohio.
Secretary, R. E. Lewis, Elec. Supt., Youngstown Sheet & Tube Co., Youngstown, Ohio.

9:30 A. M.

"Tube Type Annealing Furnaces" by Lee Wilson, Pres., Lee Wilson Engineering Co., Cleveland, Ohio.

10:00 A. M.

"Heat Resisting Castings" by Dr. F. A. Fahrenwald, Chicago, Ill.

10:45 A. M.

Discussion: Papers of Messrs. Wilson and Fahrenwald.

11:15 A. M.

"Hot Galvanizing in Connection with Sheets" by Nelson E. Cook, Gen. Supt., Galvanizing Operations, Wheeling Steel Corp., Wheeling, W. Va.

12:15 P. M.

Luncheon at the Ohio Hotel, Youngstown, Ohio.

1:15 P. M.

"Pickling, as an Operation and Practice" by H. G. Hobbs, Steel Service Division, Grasselli Chemical Co., Cleveland, Ohio.

"A New Technique in Acid Handling" by J. R. Hoover, Asst. Mgr., Chemical Sales Division, B. F. Goodrich Rubber Company, Akron, Ohio.

2:15 P. M.

"Blast Cleaning of Steel" by W. A. Rosenberger, Chief Engineer, Pangborn Corp., Hagerstown, Md.

"Cleaning of Steels" by E. A. Rich, Vice Pres., American Foundry Equipment Co., Mishawaka, Ind.

3:00 P. M.

Discussion: Galvanizing, Pickling and Cleaning Papers.

4:00 P. M.

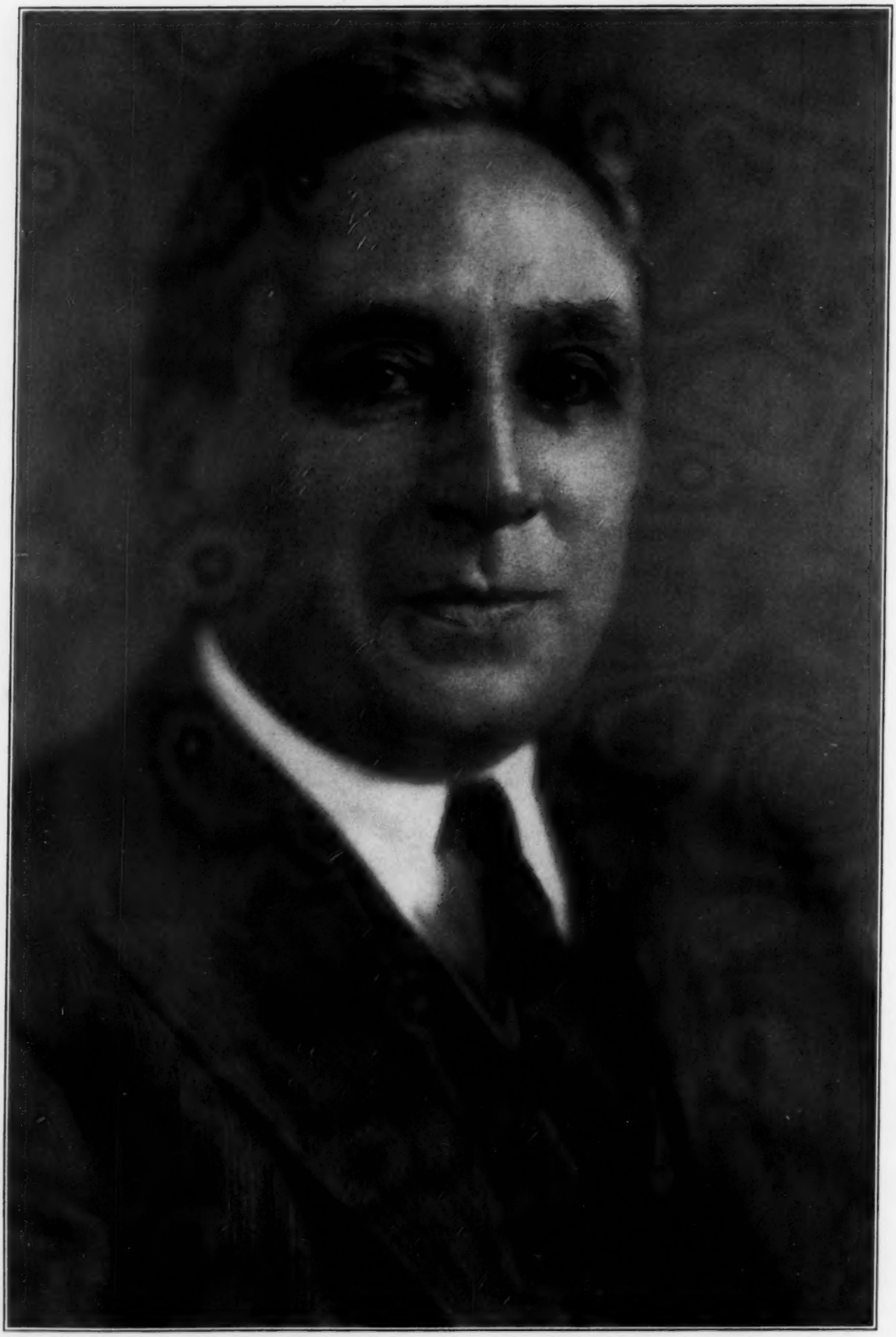
"Super Refractories in Connection with Heat Treating Furnaces" by E. C. Lloyd, Armstrong Cork and Insulation Co., Lancaster, Pa.

"The Use of Super Refractories for the Iron and Steel Industry" by W. F. Rochow, Harbison-Walker Refractories Co., Pittsburgh, Pa.

"Insulating Firebrick Applications in Steel Heating Furnaces" by M. J. Terman, Refractories Engr., Babcock & Wilcox Co., Pittsburgh, Pa.

5:30 P. M.

Discussion: Refractories Papers.



MR. FRANK PURNELL, President of the Youngstown Sheet & Tube Company, Youngstown, Ohio, extends a cordial invitation to the members of the Association of Iron and Steel Electrical Engineers to visit Youngstown on the occasion of their Annual Spring Engineering Conference.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

FRANK PURNELL
PRESIDENT

YOUNGSTOWN, OHIO

February 17, 1934

Association of Iron & Steel Electrical Engineers,
Empire Building,
Pittsburgh, Pennsylvania.

Gentlemen:

The iron and steel industry throughout the Youngstown district joins with me in extending to you a hearty welcome upon the occasion of your Engineering Conference, to be held in Youngstown on April 12.

Your meeting will possess a special significance to the people of Youngstown. Youngstown is a steel city. The whole Mahoning Valley district has been the cradle of the industry. Iron and steel and allied trades constitute today the majority of this territory's business activity.

In a city of this sort, where practically everyone is directly connected with, or to some extent dependent upon, the continuing progress of the iron and steel industry, a conference such as yours represents an important event.

People who know steel realize the contributions which engineering and research have made to the advance of the industry. They know that today's great mills and smoothly functioning processes have been made possible largely through years of scientific study and experimentation.

Upon your research of today will depend the methods and products of tomorrow. It is indeed appropriate that you should meet to discuss technical advances in the trade in a city which especially will stand to benefit from those advances.

We in Youngstown look forward to this meeting as an opportunity to renew old acquaintances, and make new ones--and I assure you that we will do our best to make your visit here a thoroughly enjoyable one.

Yours sincerely,

Frank Purnell.

FP:AP President.

SAVE WITH STEEL

SPRING ENGINEERING CONFERENCE

APRIL 11th, 12th, 1934 – YOUNGSTOWN, OHIO

▲

COMMITTEMEN

General Chairman
F. E. LEAHY, Fuel Engr.,
Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

General Secretary
J. L. MILLER, Asst. Chief Engr.,
Carnegie Steel Co.,
Youngstown, Ohio.

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F. E. LEAHY, Fuel Engr.,
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Hot Galvanizing In Connection With Sheets

By NELSON E. COOK
General Superintendent of Galvanizing Operations, Wheeling Steel Corporation, Wheeling, W. Va.

Abstract of Paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference, to be held at Youngstown, Ohio, April 11 and 12.

NELSON E. COOK

Hot Galvanizing, in connection with sheets, means, in the strict sense, the application of a Zinc coating to sheets by a hot process. Galvanizing is one of our most ancient arts, and has been developed to fill a very definite niche in the general scheme and advancement of engineering and building construction. Iron and steel sheets are finding an increasingly large number of uses and they have very important properties which account for their success. However, they have one important disadvantage which would make their use much more limited were there not some way to overcome this disadvantage. This disadvantage lies in the fact that when they are exposed to moisture, especially moisture which contains acids or corrosive salts, they corrode very rapidly. Therefore, in order to make the widest use of steel sheets, it is necessary to provide them with a coating of a corrosion resistant metal in order to prolong their life. Zinc has been widely used as this coating metal because it has very definite properties which make it one of our best protective coatings.

Galvanizing of sheets, as originally practiced, was done in a scientific way, but the product was made for entirely different purposes than the product which we make today. During the last twenty-five years there has been a gradual trend toward specialized coatings until, at the present time, the Zinc coating of sheets for the great variety of uses which are now demanded, is one of our most complicated arts.

During this development of coatings it has been necessary to enlist the knowledge of practically all branches of engineering. We must, of course, have the proper technical control in the making of the steel sheets. In the galvanizing process we must have the knowledge of the mechanical engineer in solving the mechanical problems in connection with galvanizing machinery. We must use the knowledge of the electrical engineer in providing for proper electrical equipment. We must employ the knowledge of the combustion and fuel engineer in designing the proper heating equipment for the process. We must have the knowledge of the chemical engineer in providing proper processes and control of all chemical requirements which we encounter. And, above all, we must have the knowledge of the skilled galvanizer who, after all, is, in the strict sense of the word, an Engineer, for it is necessary that he have a great amount of knowledge concerning the use of metals, and that he be able to coordinate the knowledge of all his other engineers in determining the best type of process for the particular kind of coating he is required to do.

Hot Galvanizing of sheets, by the machine method, is the same, essentially, as practiced decades ago. So far as development of coatings for special purposes is concerned, galvanizing is in its infancy. Daily, new practices, types of coatings, treatments, etc., are being developed, and it is for this reason that Galvanizing is one of our most interesting arts.

Super Refractories

By J. L. MILLER
Assistant Chief Engineer, Carnegie Steel Co., Youngstown, Ohio

The development of the so-called Super-Refractories for application in industrial furnaces and kilns is of profound importance to the Steel Industry. In fact further development is constantly at hand. The trend towards general insulation of re-heating and metallurgical furnaces in the industry has without question forced important advances already acknowledged and accepted for modern installations. The development has been in the main along two general lines, viz., First, Those used in the low temperature field say up to about 2000° F., and Second, The higher temperature field, or those above 2100° F.

Prof. F. H. Norton in his very interesting studies and writings on refractories has stated that in our selection of refractories we should divide furnaces into two general classes; first, those holding a substantially constant temperature throughout their life

and which do not fall low enough in temperature to cause serious spalling. The second class consists of periodic or intermittent furnaces which are cooled and heated either at regular or irregular intervals resulting in more or less rapid temperature changes within the spalling range.

In a recent comparison of a well known insulating refractory the following figures were given for the same insulating value per square foot of wall surface and 1600° F. inside temperature. Old style wall of 13½" of fire brick and 18" of Red brick weighed 340 pounds and has a heat capacity of about 78,000 BTU's. A modern wall built of this particular insulating refractory and 9" thick weighed about 40 pounds and has a heat capacity of about 8000 BTU's.

When we are confronted with these figures or like figures from any reliable refractory manufacturer we must certainly hesitate and take serious thought on the selection and purchase of the right refractory for the job at hand. The practical results obtained from the installation of course will be the final answer and we must weigh carefully the attempts at similation of these in the laboratory figures which we must deal with. In the final analysis our desire is to obtain the greatest degree of physical and thermo chemical stability per dollar of first cost. The cheapest refractory is then, that one which will give us the longest productive life with the greatest production per furnace hour.

Heat Resisting Castings

By DR. F. A. FAHRENWALD
Chicago, Ill.

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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conferenca, to be held at Youngstown, Ohio, April 11 and 12.

This paper examines briefly the field of available alloys having industrial heat resisting characteristics and compares all of these qualitatively in the light of various chemical and physical properties which constitute criteria of ordinary commercial utility.

The serviceability of heat-resisting alloys is briefly summarized in terms of:

Surface stability,
High temperature strength,
Phase stability,
Specific heat,
Heat transfer values,
Electrical properties,
Fabrication characteristics.

With relation to the time factor versus high-temperature strength, reference is made to the plastic properties of metals at high temperatures and it is pointed out that the criterion of utility in an alloy high temperature stress member is a permissible **rate** of deformation rather than any static strength value.

With respect to analysis versus high temperature strength, alloys of satisfactory surface resistivity are compared as to physical strength at high temperature and the influence of both major and minor constituents is described. Figures and graphs are given showing the relative beam strength of more than fifty analyses selected as typical of the commercial range. These illustrate the high temperature strength effects of variation in chromium, nickel, carbon, silicon, manganese, tungsten, molybdenum, etc., and show that certain compositions are markedly superior in terms of high temperature load carrying ability.

Design values are given for a list of selected grades in terms of figures found satisfactory under transverse loading conditions in commercial installations.

Brief discussion is offered concerning the behavior of elastic versus plastic structural members and errors which may be introduced by the employment of empirical elastic formulae for elastic materials in designing structural members of plastic materials are pointed out.

The disproportionately increased rate of deformation with increased load is pointed out and some figures given.

Relative deformation in tension and compression portions of structural members has been determined and is briefly described. The difference in high temperature strength of wrought versus cast members is referred to and the effect of foundry practice on high temperature strength is briefly discussed.

A relative order of stability against age hardening is discussed briefly and several examples given.

Thermal expansion curves for seven heat resisting alloys are given, together with curves for common refractories. Likewise curves for specific heat and heat content.

Heat transfer is discussed in terms of conduction, convection and radiation.

Thermal conductivity is given for various grades of alloy together with other common materials and also refractories.

Heat transfer to and from alloy surface is discussed briefly and the few most commonly required formulae are included.

Cast resistors are referred to and a few typical resistivity and emissivity figures are included.

Steel mill uses of heat resisting alloys are described insofar as applications have been proved to date and, some future possibilities pointed out.

Utilization of Batch Furnaces For Heating

By T. B. BECHTEL and M. H. MAWHINNEY,
The Electric Furnace Company,
Salem, Ohio

Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held at Youngstown, Ohio, April 11 and 12.

The purpose of this paper is to point out how the homely batch type furnace can be made to challenge the supremacy of the modern continuous furnace by proper arrangement of equipment.

M. A. MAWHINNEY

Thirty years ago industrial heating furnaces were almost entirely of the batch type, with the exception of large continuous furnaces for heavy billet heating, and were of extremely crude design. Accurate heat treating was unknown in the steel mills, as was the theory and practice of furnace design, as now known.

With the introduction of heat resisting alloys, continuous heat treating furnaces were built for automatic handling. Electric furnaces revolutionized temperature uniformity and control, and spurred the development of burners and control equipment for fuels, as well as refinements in furnace construction necessary to maintain atmospheres in the furnace. The automobile and kindred industries led in these developments, but with the advances in metallurgy, the steel companies became more involved, and have slowly reformed their traditional conceptions of heating furnace design and operation.

T. B. BECHTEL

In spite of the amazing developments in automatic and continuous heating equipment, which are yet continuing to grow, there are certain products which defy all effort at satisfactory continuous handling in furnaces. These products include large pipe, miscellaneous bars in odd lots of size and analysis, car wheels, miscellaneous castings, etc. Many attempts have been made to handle such products continuously and the resulting monstrosities are almost entirely unsatisfactory for one of two principle reasons. Either (A) the product is handled satisfactorily but in such manner as to prevent the possibility of satisfactory heating, which is, after all, the purpose of the furnace, or (B) the cost of maintenance of the alloy conveying means is economically unsatisfactory.

These difficulties have led to the recent introduction of the principle of multiple batch type furnaces in line, with proper handling equipment, for the solution of this problem. Briefly, this new principle comprises a series of similar single-end batch furnaces with their fronts in line and a fast handling means outside the furnaces which, in effect, ties the series of batch furnaces together to form a continuous producing unit.

There is a variety of possible arrangements, all alike in principle, and all incorporating the following principle advantages:

1—Simplicity of furnace construction with no moving parts in the heat.

2—Flexibility of capacity, since only the number of units required need be operated.

3—High economy at all rates of production since units in operation are always at maximum capacity.

4—All handling machinery available for repairs without interference to production.

A number of large installations incorporating this principle are described in the paper. For example, one installation for heat treating tubes includes eight car furnaces, each with electrically driven cars, and a special crane for handling tubes without distortion. Such a furnace can be unloaded and ten tons of tubes reloaded in a total time of three minutes. Another installation includes three batch furnaces

with a special gantry crane with projecting fingers which enter the furnace between piers and load miscellaneous castings onto these piers. In all cases, the doors are electrically operated to increase the speed and obtain the full benefits of this arrangement.

The novel arrangement of furnaces as outlined should appeal to steel mill engineers who are constantly confronted with the heating and handling of awkward and unwieldy products, and to electrical engineers particularly, because the success of the method depends upon the utilization of electrical machinery.

A New Technique In Acid Handling

By J. R. HOOVER
Asst. Manager, Chemical Sales Division, The B. F. Goodrich Rubber Co., Akron, Ohio.

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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held in Youngstown, O., April 11 and 12.

Handling acid for pickling has traditionally presented one of the most troublesome, costly, and baffling problems of steel plant equipment. Until very recently leakage and failure of acid tanks and sewers, rapid corrosion of overhead structures, disintegration of foundations and frequent shutdowns for repair were taken for granted as an inherent burden of pickling room operation.

Modern trends in steel production, involving heavy investments in continuous equipment and smaller margins of profit, have necessitated a new technique and a new point of view in acid handling. The steel engineer of today recognizes that acid leakage and the destructive effects of corrosion can be and are being prevented.

The wide variety of methods and materials which have been used will be discussed, with special emphasis upon the growing use of rubber lined steel equipment in this field.

Several fundamental developments necessarily preceded the successful application of rubber linings in steel pickling tanks:

1—The discovery in 1924 of the Vulcalock process, whereby rubber and steel can be integrally bonded. The unique resilience and corrosion resistance of rubber can thus be combined with the rigidity and structural strength of steel.

2—The development of a new three-ply rubber lining construction known as Triflex, which combines the advantages of both hard and soft rubber and eliminates apparent weaknesses of each. Adequate provision is made for expansion and contraction with changes in temperature.

3—Protective sheathings of brick to prevent physical damage to rubber lining and substantially reduce the temperature at the rubber surface.

Details of design, which have largely been developed through the co-operation of engineers and operating men in the steel industry, will be discussed.

J. R. HOOVER

Approximately one hundred pickling tanks of the steel-Triflex-Brick construction have been installed during the past four years. All are in active service today. None have developed leaks or structural defects. In most plants they have earned their cost within the first year or two of operation.

Triflex-lined steel equipment is also being successfully applied in the construction of acid fume ducts, tank covers, exhaust fans, and sewers.

Sizes of tanks range from small containers for pickling stampings and forgings to a tank fourteen feet wide, ninety feet long and eight feet deep for continuous pickling of large sheets. Two of the largest continuous strip mills in the United States are equipped with the new acid tanks—a total of eleven sixty-foot tanks in this service. Long, heavy billets are being pickled, twenty tons per load, in two forty-five foot tanks of steel-Triflex-brick construction installed during the summer of 1933.

In every case maintenance work has consisted simply in the periodic application of acid-resisting paint to the exterior. Heat from the bath within keeps the outside steel surface dry, minimizing corrosion. There have been no acid leaks, no shutdowns for repair.

Steel, rubber and brick, three widely different materials of construction, each designed to perform definite functions in the whole tank structure, combine to achieve these results. Pickling costs have been substantially reduced, working conditions improved; and a new market for steel opened up—objectives gained simply through intelligent co-operation of far-sighted engineers and operating men who refused to be satisfied with wasteful methods.

Use of Electric Furnaces for Box Annealing

By A. N. OTIS
Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held at Youngstown, O., April 11 and 12.

A. N. OTIS

The paper will discuss types of electric furnaces adapted for the box annealing of sheets in protective atmospheres, and will present curves and data to show temperature distribution obtainable throughout a stack of sheets, together with heating and cooling rates with furnaces employing recirculation system for forced cooling.

These furnaces do not employ cover hoods or retorts for the heating operation, thus eliminating the expense of such retorts, and permitting accurate application of the heat energy to obtain uniformity of temperature distribution.

The paper will also discuss types of furnaces adapted to box annealing coils of wide strip, and will present data regarding the output and expected economies of such furnaces.

Insulating Firebrick Applications In Steel Heating Furnaces

By M. J. TERMAN
Refractories Engineer, Babcock & Wilcox Company, Pittsburgh, Pa.

Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held at Youngstown, Ohio, April 11 and 12.

M. J. TERMAN

Increasing demands for fuel economies, time savings and improvement in quality of finished products have led to a broadening of the applications of insulating firebrick in steel heating furnaces during the past three years.

Although for many years insulating materials have been used only for backing up refractory brick walls to retard the flow of heat, recent research and development work have made available materials possessing the necessary qualities of thermal efficiency and mechanical stability for direct exposure to elevated furnace temperatures.

Characteristics of insulating firebrick essential to satisfactory performance are discussed. These include lightness of weight, mechanical strength, low heat flow, low thermal capacity, spalling resistance and freedom from shrinkage.

Several advantages of using insulating firebrick versus heavy fireclay brick linings in furnace con-

struction are presented as: (1) time saved in bringing a furnace to operating temperature. This, on a cold start, ranges from 25% to 85%, depending on size and type of furnace, limitations on rate of heating stock, burner arrangement and temperature control; (2) fuel savings; (3) flexibility of temperature control; (4) increase in furnace output due to uniform temperature distribution; (5) saving in floor space for same hearth area by reduction of wall thickness; (6) improved working conditions around furnace; (7) improvement in quality of product.

Data on heat flow and heat capacity of several walls are given in tabulated form. An interesting comparison of two walls of equal heat flow at thermal equilibrium shows that, at a furnace temperature of 2800° F., the insulating firebrick wall has a thermal capacity of 8750 B.t.u. per sq. ft., whereas the heavy wall backed up with insulation has 91,500 B.t.u. per sq. ft., a ratio of approximately 1 to 10.

Other data, in graphical form, show temperature distribution in two walls ((1) insulating firebrick and (2) first quality fireclay brick backed up with insulation) from a cold start up to the establishment of thermal equilibrium.

Several insulating firebrick installations are cited and illustrated. Comparative operating data are given on sheet normalizing, billet heating, annealing and heat treating furnaces.

Cleaning of Steels

By E. A. RICH
Vice President, American Foundry Equipment Company, Mishawaka, Ind.

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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held in Youngstown, Ohio, April 11 and 12.

The conception of the principle employed in the Airless Wheelabrator is very old. Patents embodying this idea were taken out as early as 1870. Since that time innumerable patents have been taken out, each of them embodying some variation of the original conception. In other words, the desirability of performing the function of abrasive cleaning without the use of compressed air has been recognized for over half a century and the numerous patents that have been taken out attest to the value and importance of the idea, the only difficulty being that "it wouldn't work." There are many reasons for this failure, most of them minor reasons, but there were three outstanding reasons why "it wouldn't work."

First. The critical speeds were not discovered and employed.

Second. The action of the abrasive was so destructive to the wheel itself and the collateral mechanism that the machinery would destroy itself before results commensurate to its cost could be obtained.

Third. Means for control of the direction of abrasive delivery could not be found.

The American Foundry Equipment Company does not claim credit for the discovery of critical speeds. Credit for this is due Alfred V. Hollingsworth, who spent many years running experiments and tests, and who finally discovered the means of getting highly efficient results, but to whom the remaining two problems—viz: Protection of the device itself and directional control—remained undiscovered.

Hollingsworth's experiments, however, demonstrated so much promise that the American Foundry Equipment Company negotiated with him and acquired the exclusive right to his discoveries and patent applications and carried the work forward from that point, running, literally, thousands of varying tests and spending tens of thousands of dollars in development and research extending over a considerable period of time.

It was discovered that there are three important forces that must be employed to obtain the results—viz: Centrifugal, tangential and air-dynamic. The next question was to bring these forces under control.

E. A. RICH

Finally, the means for protecting the device from self-destruction was discovered. The next step was to obtain directional control. This problem, after months of experimentation and discouragement, was also solved.

The first successful installation of a machine, employing the forces above mentioned and actually operating on a commercial basis, was placed in the plant of the Inland Steel Company at Indiana Harbor in April, 1933. It has since processed tens of thousands of tons of bar stock for automobile bumper bars and other similar purposes, and is in successful operation today.

Since then, numerous other installations have been made, most of them in foundries cleaning castings of many kinds and varieties and in motor car plants cleaning forgings and other parts, included among which are the coil springs for the famous

"knee-action" front wheel springs of General Motor cars.

One large mill has a wheel that has been in operation for many months cleaning sheets of various types, including cold rolled stock and galvanized stock, and especially cleaning lighter gauge sheets for various purposes, including tin plate and other sheets running as low as 30 gauge. In one instance, a batch of twenty-five tons of light gauge sheets for a special purpose, which had been spoiled in the rolling, was salvaged by means of the Wheelabrator. This material would otherwise have been scrapped.

Still another application is the cleaning of scale from steel tubes used for roller bearing cases. Some of this stock has the anneal scale resulting from over seventy hours annealing, and the producers of this material tell us that they have found no other means, not even pickling, by which this could be satisfactorily processed other than by the Wheelabrator.

Temperature Distribution In Electric Furnaces Compared to Fuel Fired Furnaces

By WIRT S. SCOTT
Special Representative, Westinghouse Electric & Manufacturing Company, Mansfield, Ohio

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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference, to be held at Youngstown, Ohio, April 11 and 12

The older a custom or art, the more we are apt to take for granted that all is well with it, and turn our attention to improving everything else but the very thing which needs attention most. For many years, the progress made in heat treating furnaces was mainly towards improving the efficiency of operation so as to reduce fuel or power consumption to a minimum, neglecting to a great extent the fact that the principal function of a furnace is to heat treat a product as perfectly as possible, not to save fuel or electric power.

Metallurgists are able to determine, microscopically, the grain structure resulting from every known heat treating process, and the effect of time and temperature on the physical structure of metals. Armed with this important data, they are able to predetermine the exact temperature to which a given metal should be heat treated to develop the maximum physical property the metal is capable of producing, such as hardness, softness, ductility, etc.

However, expert metallurgists, observing and studying grain structure through powerful microscopes, do not produce properly heat treated metals. Equipment must be available for supplementing such valuable, scientific aid. The metallurgist's or the shop's inability to test only a small percentage of the heat treated products, resulted in too great reliance being placed on the temperature controlling pyrometers as evidence that the specifications were being met in all their requirements. One important fact had been almost entirely overlooked, i. e., that a pyrometer indicated or controlled the temperature at the thermocouple **only,** and that three feet away from the thermocouple, the temperature may be 100 degrees higher or lower.

Metallurgists usually have facilities for making accurate investigations for determining the proper heat treatment procedure to obtain certain physical properties. In a laboratory furnace, the equipment is of relatively small dimensions, and the test specimen may be located very close to the temperature controlling thermocouple. However, the shop may, or may not, have equipment capable of duplicating such test results. A manufacturer may therefore be penalizing himself by using equipment in the heat treating department which is incapable of producing physical results attainable in the laboratory. In any event, these facts should be definitely determined.

WIRT S. SCOTT

Such a condition is not the fault of the metallurgist or the metal. The responsibility rests entirely with the management. Seldom would a metallurgist care to set up shop specifications so strict that a large percentage of the product would be rejected. He has to make the best out of the heat treating equipment available. Nevertheless, there are certain responsibilities which are someone's duty to exercise. These may be enumerated as follows:

1. Determine the correct heat treating temperature for the particular metal in production, and the maximum temperature variation from normal which will produce the physical properties desired.

2. Explore, with thermocouples, the charge in the shop furnace, and find just what percentage of the material is now being heat treated at the proper temperature.

3. Determine the manner in which the shop, the sales department, and the user are being penalized by a non-uniform product. Evaluate this penalty in dollars and cents.

4. In purchasing a furnace, specify that temperatures must be thoroughly explored throughout the charge under operating conditions, and that the maximum variation in a representative load be not more than a prescribed number of degrees, plus or minus, from a given temperature. The uniformity of heat distribution must be such as will give the metallurgical result required.

Temperature control has no relation to heat distribution. "Temperature control" is accomplished by automatic devices actuated by a pyrometer measuring the temperature at **one point** in the furnace. Such a combination of equipment may be applied to almost any kind of a furnace. "Heat distribution" has nothing whatever to do with the temperature control equipment. Heat distribution is strictly a function of the furnace design and construction. **Uniform heat distribution,** the result necessary for **correct heat treatment,** is the liberation of heat within a furnace chamber in **definite places,** and in **definite amounts.** so as to correctly compensate for all radiation and door losses, and then supply heat to all exposed surfaces of the charge, in **definite amounts** and at the **proper temperature to heat the charge uniformly.**

Galvanizing

By F. E. LEAHY
Fuel Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio

The coating of the surface of steel products with zinc, known as Galvanizing, has been practiced for years to provide a surface more impervious than the steel to weathering.

In the past, the coating of the fabricated or finished article was the operation performed after the forming or mechanical work had been completed.

Now the fabricators wish to start with galvanized materials before forming, in order to affect economies in their operations, which requires a change in the practice of galvanizing.

This requires a galvanized material with a coating sufficiently ductile and adherent to withstand the forming operations without peeling, flaking or checking.

Commercial zinc is generally classified as brittle, limiting the amount of deformation it will withstand.

As a result, it is necessary to resort to combinations of alloys of zinc in order to produce the proper coating.

While progress has been made, there are still many problems awaiting solution before the galvanizing practice can be placed on the scientific basis where it rightfully belongs.

Electro Deposition Of Metals

By JOHN F. KELLY
Managing Director, Association of Iron and Steel Electrical Engineers

Twenty-five years ago manufacturers of Electro Plating Equipment began specifying coatings in definite terms of so much weight per square foot of surface, usually expressed in one-sixth of an ounce, one-quarter of an ounce, one-third of an ounce or one-half an ounce per square foot.

At that time it was about the only practical way the manufacturer had to express himself, today, very definite information and data is available for the users of electro plating equipment. From the advances being made in the art of Electro Deposition of Metals the Steel Industry will be and is one of the most potential customers for this particular type of equipment.

New uses for steel, (and new uses are gradually being opened up), will no doubt require special coatings for finish and protection.

The continuous rolling of strip steel opens up a wide field for continuous zinc plating or galvanizing. This new field also lends itself to copper, nickel and chromium plating for highly finished strip products.

Recently the Tin Plate Industry has shown considerable interest in Electro Copper Plating of steel sheets, to be used as cans in which oil will be shipped from the refinery to the filling stations. Several installations have already been made for copper plating using cut-to-size sheets. It is predicted, however, that this process will be superseded by the use of strip and continuous plating. For a given production per hour it would seem logical to assume that the continuous process would be the most economical, however, at this particular time, it is a debatable question.

In the copper plating of strip steel for the manufacture of oil cans, the specifications originally estimated that a deposit of copper .00001" to .000015" on each side would be sufficient. This, however, has been increased recently so that the coating now specified may be .00002" to .00003" in thickness. It is claimed that a coating of .00002" will require .5 grams of copper per square foot of surface and this will be approximately one-half pound of copper per base box.

Manufacturers are offering a unit to handle strip steel up to 30" in width and in thickness from number 26 to 34 gauge at a speed of about 65 feet per minute. The length required for this equipment from the first roll on the acid tank to the wipe after the hot water rinse is approximately 150 feet.

The current required for this type of copper plating tank is about a 7500 ampere motor generator set.

The output based on strip steel 30" wide would be approximately 44 base boxes per hour.

The Steel Industry as a whole would do well to investigate the advance and the progress made in the arts of Electro Deposition of Metals to their present products.

Tube Type Annealing Furnaces

By LEE WILSON
President, Lee Wilson Engineering Co., Cleveland, Ohio

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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference, to be held at Youngstown, Ohio, April 11 and 12.

The past 50 years have produced very few changes in box annealing furnaces. Many improvements have been made in methods of determing the temperature of the sheets, but little or no successful work has been done to eliminate the glaring faults of orthodox box annealing furnaces.

These faults are—(1) The necessity of heating a cover and tray that normally weighs as much as the charge being heated. (2) Concentration of weight at the bottom of the furnace where it is hardest to heat. (3) Lack of sufficient bottom heating to compensate for the extra weight in the bottom.

To eliminate these disadvantages, the Wilson Tube Type Annealing Furnace has been built. The Tube Type Furnace has eliminated these disadvantages, and has proven to have many other advantages as well.

The Tube Type Furnace is similar in design to an electric bell type annealing furnace. The electric heating elements being replaced with individually fiired alloy tubes. These gas fired tubes are arranged along each side of the furnace with the ends extending through the side walls. Each tube is heated by a gas burner located at the bottom. The gas is burned inside of the tube, and is exhausted to the atmosphere at the top. The heat is transferred from the tube to the pile of sheets by radiation.

The furnace consists of two parts, a base or bases, upon which the material to be annealed is piled, and the bell or furnace proper. The bell or furnace is constructed of welded steel plate, lined with insulating refractories, and has all necessary burners, valves and fans attached to it. This portion of the furnace is completely self contained and can be moved from base to base. Gas and electric connections are easily made by means of a flexible hose, and electric plug.

A series of production tests have proven that very rapid uniform heating is obtained. It is possible to heat the bottom of the pile as rapidly as the top. Distribution of heat from top to bottom of the furnaces is readily obtained, by burner regulation.

The time necessary for heating and soaking has been cut to about 60% of that normally required.

It is possible to control the cooling cycle by using the tubes as cooling mediums. Temperature drops of 50 degrees an hour can be obtained, or a normal cooling of 10 degrees an hour is possible. By regulation of the amount of air passing through the tubes, any reasonable rate of cooling is possible.

Fuel costs using 45c natural gas compare favorably with costs on hand fired box annealing furnaces, using $1.80 coal. The average figure for 1400 degree annealing has been about 1,300,000 B.T.u. per ton of sheets annealed. The average for low temperature annealing has been about 1,000,000 B.t.u. Recent improvements in design will further reduce these figures we believe.

The elimination of the cover and tray is a big advantage from a stand point of heating and fuel economy. There is also a direct saving in replacement costs of this equipment of from 30 to 40 cents per ton. The old style sand seal is replaced by an oil seal which is out side of the furnace, positive in action, and easily accessible.

The design of the Tube Type Furnace lends itself to simple, rugged construction, and is reasonable in first cost.

The following advantages have been proven on production jobs:

1—Positive control of heating and cooling cycles.
2—Positive control of heat distribution.
3—Shorter heating cycles.
4—Elimination of box and tray.
5—Positive sealing.
6—Low fuel costs.

Blast Cleaning Of Steel

By W. A. ROSENBERGER
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Abstract of paper to be presented before the Combustion Engineering Division of the A. I & S. E. E. at the Spring Engineering Conference to be held in Youngstown, Ohio, April 11 and 12.

The author, after a brief historical review in which he pays tribute to Mr. Brooksbank, one of the pioneers in this field, expounds briefly and interestingly the theory of this process from which the tremendous destructive force of fast moving abrasive particles is vividly explained. He describes the method used by him to determine the actual speed of flying abrasive, the effect of distance between nozzle and work as well as the effect of the angle of the blast.

Next, the various kinds and types of abrasives in general use today are touched upon; samples shown as well as samples showing the effect of the various grades of abrasives upon metal.

The author thus briefly explains the three principles of air blasting, namely: Direct Pressure, Gravity and Suction, followed by remarks on various types of nozzles through proper arrangement with respect to the work to be cleaned.

This is followed by remarks on air pressures and

a proof that the air velocities through any size nozzle, irrespective of pressure, is constant. The advantage of high pressure over low pressure for hand operated blast equipment is pointed out.

The author next briefly describes commercial types of equipment, circumscribing their relative merits for various types of work and for varying production requirements. Amongst other things he briefly discusses the recent development of the hydroblast equipment and of the Centrifugal blast.

He then goes over to specific application in the steel industry, touching on equipment for processing steel sheets, plates, rolled shapes, etc., including various methods so far applied in handling such work passed the blast stream. He discusses the speed of the work, nozzle arrangement, abrasive distribution.

Following this, various work handling methods are described and many points are brought out which will give the prospective user of such equipment a clearer understanding of the problems involved.

An interesting part of the paper is devoted to auxiliary equipment such as ventilating and Dust Collecting Systems, automatic abrasive handling and recovery methods with particular emphasis on the importance of proper abrasive separation.

W. A. ROSENBERGER

The paper concludes with a few remarks on protective devices for operators and a speculation on the future developments of this industry.

The Use of Super-Refractories For The Iron and Steel Industry

By W. F. ROCHOW
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Abstract of paper to be presented before the Combustion Engineering Division of the A. I & S. E. E. at the Spring Engineering Conference to be held in Youngstown, Ohio, April 11 and 12.

The commonly used term, super-refractory, seems to be so comprehensive in its general interpretation, that it can hardly be defined concisely to bring out its full meaning. If as the name is loosely used, it is taken to mean a refractory of a given type, that is appreciably better in its physical and chemical properties than the average of that class, then the definition is simple enough. For example, a super-fireclay brick stands out somewhat by itself, among brick which in this discussion we will refer to as normal or regular high heat duty or first quality fireclay brick, yet as compared with high-alumina brick of even the lowest alumina content, namely 50% as commercially classified, it falls far short in refractoriness and other physical properties. To endeavor to illustrate further, high-alumina brick as used in some industries are the accepted standard type of refractory for certain parts of the furnaces and are not regarded as super-refractories.

Perhaps the subject can be discussed to best advantage by reviewing some of the noteworthy developments in the improvement of refractories as well as some worth while accomplishments in the most judicious applications of various types of refractories.

Fireclay brick, the most important refractory in the alumina-silica class, from the standpoint of widest economical utility, have passed through an evolution of important improvements in recent years. Even though an increment of improvement in the special "Super firebrick" over the best regular fireclay brick be relatively slight, at a material increase in cost, it has proved worth while for some uses. Such brick are manufactured commercially and are used to considerable advantage in certain applications. Brick in this class which are measurably better in one or more properties than the average high heat duty fireclay brick are produced by the special selection of clays or kaolins, the addition of small amounts of more refractory high-alumina materials such as diaspore and minerals of the cyanite group.

High-alumina refractories have become widely used only during the past ten years. To do without them now would leave a wide gap in the field of refractory needs. The brick in this class which are used in the largest tonnages are made from the mineral diaspore and to some extent some bauxite.

In the iron and steel industry high-alumina brick are becoming more extensively used in blast furnace stoves, open hearth checkers, and water-cooled ports as well as in various other applications.

Among the developments in the manufacture of basic refractories are some which hold promise of considerable importance. Magnesite brick of low iron content have decided advantages over the usual

magnesite refractories, for certain applications. Unburned, chemically bonded magnesite brick are used with metal casings where spalling conditions are especially severe. A quick setting magnesite has been produced, which can be used for making very substantial patches to open hearth bottoms. Chrome brick of improved spalling resistance and high temperature strength, very possibly can be expected to contribute to increased service in parts of open hearth furnaces.

During the past several years there have been some splendid demonstrations of possible fuel saving resulting from the insulation of furnaces which are necessarily operated at high temperatures. The scope of furnace insulation is extended with the development of light weight refractories having high insulating value. Insulating brick, which are suitable for use at temperatures as high as 2950° F. are now manufactured commercially.

Pickling, As An Operation and A Practice

By H. G. HOBBS,
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Abstract of paper to be presented before the Combustion Engineering Division of the A. I. & S. E. E. at the Spring Engineering Conference to be held in Youngstown, Ohio, April 11 and 12.

Sulphuric acid was first used to pickle tin plate in 1806.

This brief statement, found in a small volume entitled, "The Chronology of Iron and Steel", by S. L. Goodale, refers to a new operation and a new practice, and fixes the approximate date of its introduction; an operation and a practice which has expanded and grown until today it is one of the most important processes through which steel must go in the course of its manufacture.

H. G. HOBBS

The history of this operation and practice as it was, how it was accepted by operating departments, the little attention it received, and the poor equipment and slipshod methods of control which were a part of it; and a complete outline of this operation and practice as it is today with modern controls and equipment, the universal acceptance of its importance, and the far-reaching effect it has on the finished product, will be the subject of a paper entitled, "Pickling, As an Operation and a Practice", which will be read by the author at the forthcoming meeting of the Association of Iron and Steel Electrical Engineers in Youngstown, Ohio, April 12th.

Heat-Resisting Alloys

By M. J. R. MORRIS,
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In recent years, the so-called stainless and heat-resistant alloys have come to occupy an important position in modern steel mills and fabricating plants.

The stainless alloys usually include the chromium iron and chromium-nickel iron alloys, containing up to 18% chromium, with or without 8% nickel.

The higher alloys, containing up to 30% or more chromium, or up to 60% nickel with 15% to 20% chromium, are generally used only for heat-resistance. In addition to chromium and nickel, other elements are added to impart specific properties under high heat. Silicon in amounts up to two or three per cent will greatly increase the resistance to scaling and will hold the scale from flaking on cooling. Tungsten will materially increase the physical strength at high temperatures where loads are applied for short periods. Molybdenum will raise the creep strength, which is the load a member will carry safely on continued heating without stretching more than 1% of itself after 10,000 or 100,000 hours, or whatever time is desired.

These alloys, depending on the analysis, are capable of withstanding heats up to 2000/2100 degrees Fahrenheit. They are used for furnace parts, such as walking beams, conveyor rollers, tube hangers, still tubes, continuous carburizing, annealing and heat-treating muffles, etc. They are used in recuperators and heat exchangers in the form of sheets and tubes; for sheet, tin, strip, and various other

types of annealing pots and boxes; also for general uses, such as carburizing boxes, lead pots, rabble arms, etc.

In selecting any of these alloys, their particular characteristics should be borne in mind. The straight chromium alloys have a tendency to become brittle if held at 900 degrees Fahrenheit for long periods without going higher, and may crack when cold after such service. Likewise, they suffer a grain growth at temperatures over 1700 degrees Fahrenheit and are apt to go brittle from this angle. However, they are tough and ductile at elevated or operating temperatures, are not affected by sulphur gases and expand and contract a little less than mild steel.

The chromium-nickel alloys are much stronger than the chromium alloys at high temperatures, and should be used wherever a fairly heavy load is to be carried. They suffer corrosion from sulphur gas at temperatures over 1000 degrees Fahrenheit, expand and contract about 60% more than steel but do not become embrittled at high or low temperatures. The high expansion may cause cracking in some cases where the chromium alloys would stand up satisfactorily.

In general, most problems of a heat-resisting nature encountered in the steel plant can be accommodated with one of more of these alloys, and it is only necessary to apply the right product in the proper place. Likewise, there are some applications and conditions where heat-resisting metals are not suitable and where they should not be considered.

Developments In Pickling

By J. H. SNYDER
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Pickling is the operation of immersing metals in suitable solutions for the purpose of removing oxides in the form of scale from the surface. Pickling is one of the best methods of obtaining a clean metal surface which is of such vital importance in tinning, galvanizing, plating, etc.

The formation of oxide occurs at ordinary temperatures but increases as temperatures increase, and is exceedingly rapid from 950° F. up. The most satisfactory method of removing this scale is through the use of mechanical equipment for immersion in acid of the material being cleaned. The use of inhibitors has added further to the advantages of mechanical pickling by the elimination of the possibility of over-pickling.

In the process of pickling, if the material to be cleaned is immersed in the acid solution, ferrous sulphate is formed around the material and action is retarded and delayed. By the use of mechanical equipment the material may be kept in motion while in the acid, thus exposing all the surfaces to the action of the acid. With this mechanical action, acid layers of different densities are never allowed to form. Even though the scale on the material is of varying thickness, by the use of inhibitors the process results in even and perfect pickling over the entire surface. By the use of mechanical equipment the pickling operation is greatly speeded and the possibility of delays in production schedules is reduced.

One of the most widely used pieces of equipment for pickling is the Mesta Patented Pickling Machine, a picture of which can be seen in Fig. 1 which is reproduced through the courtesy of the J. H. Williams Co. It is available to accommodate almost any arrangement or combination of vats required for acid, water, cleaning material, etc. Crane service is not necessary since the machine acts as a crane when lifting the crates of loaded material in and out of the vats or when transferring them from one vat to another. Steam is necessary in any pickling operation to heat the vats. The use of steam as a motive power for moving the load is naturally the most economical source of power. The patented pickling machine requires the same amount of steam as is required to heat the vats, and consequently there is no additional cost of steam for driving the machine.

The patented pickling machine is adapted to pickling a wide variety of materials. Automobile body sheets probably represent the largest tonnage item that must be perfectly cleaned. This operation starts in the mills on break-downs. The break-downs, as they come from the mill into the pickling department, are cooled in the first vat which contains water. They are transferred to the second vat which contains a 66° Baume sulphuric acid solution of 6% to 8% by volume. The third vat contains a 3% to

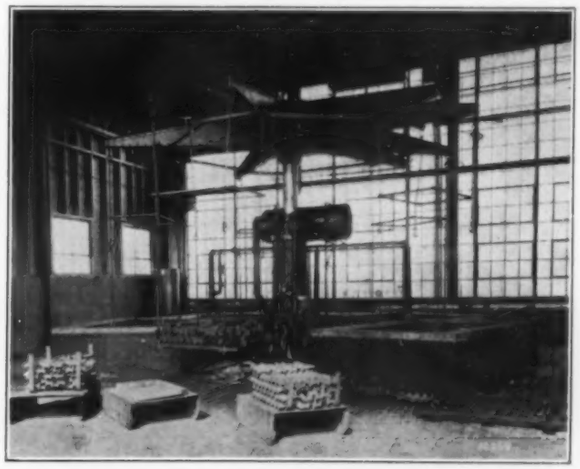

FIG. 1—Photograph illustrating Patented Pickling Machine.

4% acid solution which is replenished by the sheets carrying stronger acid over from the first acid vat. Passing to the fourth vat, the sheets are rinsed in water, and the fifth vat contains any solution necessary for further processing. A load can be taken from the machine every four to five minutes. This means a capacity of 840 tons per day of twenty-four hours.

In pickling large tonnages, as described in the previous paragraph, the first acid vat should be drained every six or eight hours, and the second acid vat once in twenty-four hours. During pickling operations acid vat temperatures should be kept at 175° to 180° F.

Miscellaneous parts such as automobile forgings can also be pickled with the pickling machine to

advantage. A four arm machine has sufficient capacity for this class of material. Smaller vats and smaller crates are used since the exposed surface per ton is less.

Forgings to be pickled are placed on grid crates or in special baskets designed for convenience in loading and unloading. When forgings are of high grade alloy, longer time is necessary to pickle than with ordinary carbon steel. A short stroke and smaller number of strokes of the machine per minute will give the most satisfactory results.

Alloy forgings are subjected to a solution of 66° Baume sulphuric acid solution, 12% to 14% by volume, in the first acid vat. For economy in acid the load for final cleaning is swung to a second acid vat in which the solution is weaker but replenished from the adhering acid from the forgings transferred from the first acid vat. Then the forgings are rinsed in a third vat. In order to gain additional tonnage when pickling high grade forgings, additional acid vats may be added as desired.

An inhibitor should always be used in pickling forged material.

Because of the variation in grades of alloy steel, it is impossible to give definite facts on the tonnage pickled in a day. However, considering the grade of drop forgings used for automobile parts today, fifty to seventy-five tons can be pickled every twenty-four hours.

To insure thorough, even pickling and clean the large tonnages necessary, mechanical methods are imperative. The movement of the material in the acid as produced by the patented pickling machine has never been approached by any other means. The snap or rebound which an elastic gas produces cannot be obtained by mechanical means, and consequently the patented pickling machine still retains steam or air as the most desirable driving medium for pickling.

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Electrical Features of Modern Cold Roll Strip Mills

By A. F. KENYON
General Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Presented before the Electrical Engineering Division of the A. I. & S. E. E. at the Twenty-ninth Convention, in Pittsburgh, October 17, 1933.

A. F. KENYON

The process of cold rolling for the production of steel strip, with highly finished surface and of accurate and uniform gauge, has been actively practiced for a half century or more. The equipment and operating procedure for the cold rolling and associated pickling, cleaning, annealing, treating, and other processes, have undergone continuous development and improvement. Each succeeding year has witnessed some definite contribution toward more economical operation, improved quality of product, or extension of the range of sizes and grades of material produced. Less than ten years ago, 24 inches was the maximum width of strip which could be commercially cold rolled, while as this paper is being written, one plant is installing two 84 inch mills to cold roll strip up to 76 inches wide, in sheet gauges and in coils several thousand feet long. Within the last two or three years, improvements in the methods of cooling the rolls and strip and of controlling the roll contour, have enabled cold rolling at greatly increased speeds, so that there are now two 42 inch mills operating successfully at 800 F.P.M. strip delivery speed, and before the close of this year there will be placed in operation a 42 inch mill designed for a maximum rolling speed in excess of 1100 FPM., and with a reel capacity to handle finished coils weighing 12,000 pounds, and containing nearly two miles of 32 gauge (0.010 inch thick) strip for tinplate.

The development of new types and the improvement of previously developed types of mill equipment for cold rolling, have been accompanied by the parallel development and improvement of the mill and reel drive electrical equipment. Practically every development and improvement in the mill equipment and in the rolling and treating processes, has imposed more exacting requirements on the motor and control equipment, and the electrical manufacturers have developed machines having the special characteristics, and control equipment providing the operating features and flexibility of adjustment, to more than meet these increasingly difficult operating conditions. The successful cold rolling of wide thin strip at high delivery speeds depends to a considerable extent upon the performance of the mill and reel drives, and the contributions of the electrical manufacturers in developing motor and control equipment with the necessary special characteristics, are no less notable than the contributions of the mill builders and mill operators in developing the mechanical equipment and the rolling and treating processes.

During the period of the last several years one of the oustanding advancements has been the development of cold rolling equipment and processes for the production of strip material up to about 36 inches wide, down to about 0.006 inch thick (38 gauge), and several thousand feet long, used for tinplate. The cost of production by the cold rolling process is about the same as by the more familiar hot tin mill process; the cold rolled material has superior qualities for deep drawing and other uses where it is formed to shape; and the long strip form of the cold rolled product may in some cases be more economically used in automatic stamping or forming machines.

Three distinct types or arrangements of the mill equipment have been developed and are in use producing cold rolled strip for tinning. These mill types are as follows:

A—Tandem or continuous mills, consisting of from three to five roll stands and a tension winding reel, arranged in a continuous line, so that the strip passes successively through the several roll stands, and is coiled under tension as it is delivered from the last stand.

B—Single stand reversible mills, consisting of a single roll stand and a reel on each side of the roll stand, with both the mill rolls and the reels motor driven, arranged for reversible operation so that the strip may be passed back and forth through the single set of rolls for the three to six passes necessary to effect the required total reduction.

C—Steckel type mills, consisting of a single roll stand and a reel on each side of this roll stand, with power applied to the reels only and not to the die rolls, arranged for reversible operation so that the strip may be pulled back and forth through the single set of rolls

by the tension exerted on the strip by the winding reel.

Each type of mill imposes a different combination of requirements on the eletrical drive, and even mills of the same general type or arrangement may operate under different conditions. Hence it is essential that each proposed installation be thoroughly analyzed and that all operating conditions be given careful consideration, in order that the electrical equipment finally specified may have the special characteristics necessary for the successful performance of the particular installation.

It is obviously impossible in the short time available to describe in detail or even to list all of the many features found in the electrical drives of cold roll strip mills, and the speaker will therefore endeavor to confine his paper to a discussion of only the more important electrical features of the various types of mills listed above. The mill equipment and its operation will be described briefly to more clearly indicate the necessity for certain electrical features. In thus briefly mentioning some of the design and operating characteristics of the various types of mills, it is not the intention to seem to favor any particular type of mill, but only to indicate some of the electrical features which we consider desirable or necessary for the successful operation of that particular type of mill under the conditions specified by the mill builder or operator.

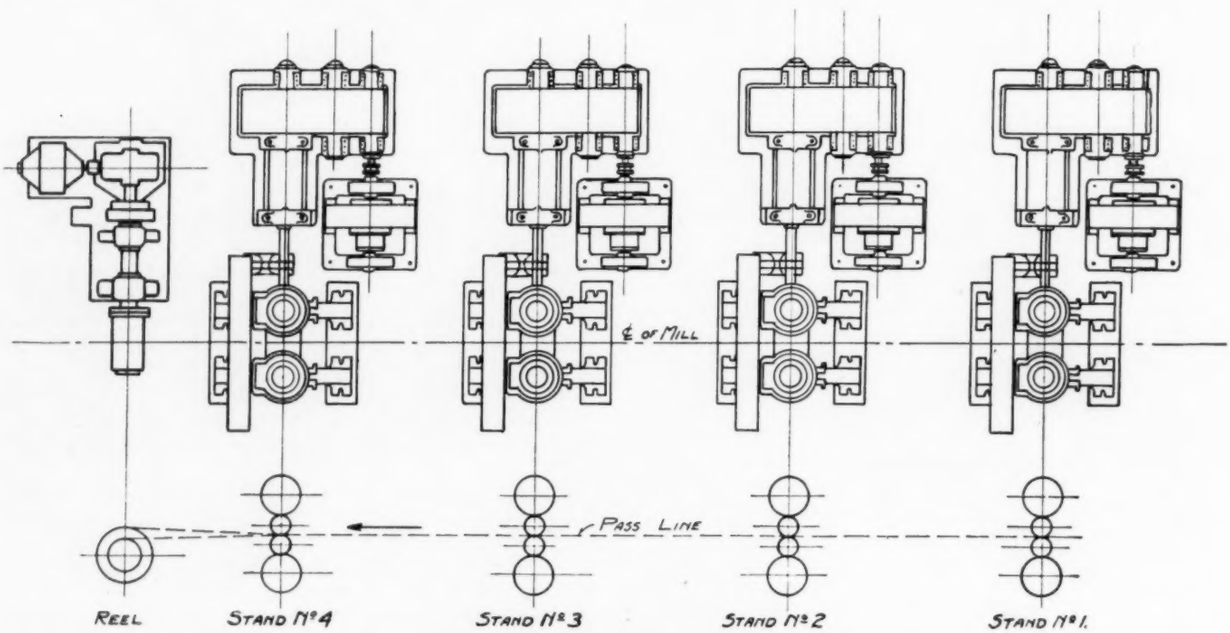


FIG. 1—General Arrangement of Four-Stand Tandem Cold Roll Strip Mill.

A—Tandem Mills

Tandem cold roll strip mills to produce light gauge strip up to 36 inches wide, such as used for tinplate, usually consist of four or occasionally five roll stands, arranged about 18 to 20 feet apart in a continuous line, and a reel following the last roll stand to wind the strip into tight coils as it is delivered from the rolling mill. The roll stands of any mill producing strip wider than about 20 inches are invariably of the backed-up type, in which the small working rolls, 12 to 16 inches in diameter, are backed-up and supported against bending by large backing-up rolls which may be from 32 to 48 inches in diameter. When rolling strip 36 inches wide, the force tending to separate the rolls may be as great as 2 to 3 million pounds, corresponding to a load of 1 to 1½ million pounds per bearing, and roller bearings are used on the backing-up rolls, and frequently on the working rolls also, to reduce the bearing friction and to minimize the roll distortion due to the heating of the roll necks.

Figure 1 shows the plan view and schematic elevation of a typical tandem mill, consisting of four four-high roll stands and a winding reel. Figure 2 shows the installation of such a 14" and 34" x 42" tandem mill, viewed from the entry end. Figure 3 shows another installation, viewed from above, and distinctly shows the arrangement of the roll stands, combination pinion stand and reduction gear sets, and 600 HP. driving motors. Note in Figures 1 and 2, that the mill motors are located alongside of the pinion stands, between the reduction gear sets and the mill stands. This compact arrangement requires a minimum of floor space, and may be quite suitable for small mills. However on larger mills this arrangement is not to be recommended, as the equipment is so crowded together that it is inaccessible for maintenance or repair; the motors encroach on the space near the mill so that the operators are hampered in their normal operation of the mill; and the motors are exposed to the oil vapor and other mill dirt with consequent greater danger of insulation breakdown and other failures. In the installation shown in Figure 3, the mill motors are located on the side of the reduction gear sets away from the mill stands, thus relieving the over-crowded condition, and also affording greater protection to the motors. Modern cold roll mills operating at fairly high rolling speeds, and making heavy reductions, require

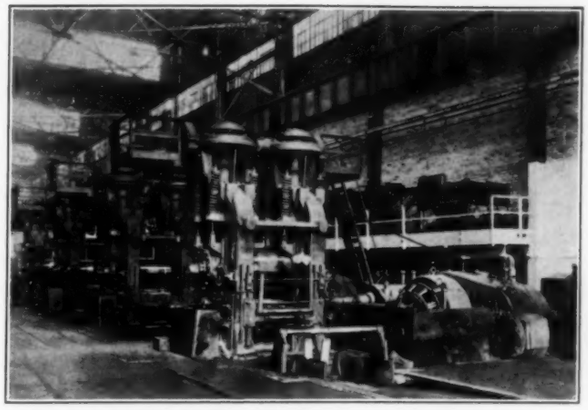


FIG. 2—Installation of 14" and 34" x 42" Tandem Cold Roll Mill.

artificial cooling of the rolls and strip with oil or water, with the result that the atmosphere is saturated with oil and water vapor, and even with the motors located as shown in Figure 3, it is recommended that the motors be equipped with enclosing endbells and be force ventilated, or that they be housed in a ventilated motor room.

A typical schedule for rolling 32 gauge tinplate stock from 16 gauge hot rolled strip in four passes is as follows:

Pass Number	Thickness After Pass	Percent Reduction
	.062	
1	.035	43.5
2	.018	48.5
3	.012	33.3
4	.010	16.7

Although on certain grades of mild steel, some mills are able to roll 32 gauge from 14 gauge in the same number of passes with correspondingly heavier reductions about as shown below:

Pass Number	Thickness After Pass	Percent Reduction
	.078	
1	.044	43.5
2	.019	56.8
3	.0125	34.0
4	.010	20.0

or 32 gauge may be rolled from 13 gauge hot rolled strip in five passes with about the following reductions:

Pass Number	Thickness After Pass	Percent Reduction
	.094	
1	.062	34.0
2	.033	46.8
3	.018	45.5
4	.012	33.3
5	.010	16.7

The strip delivery speed of most of the tandem cold roll mills now in operation producing tinplate and similar thin gauge stock, is relatively slow, various mills ranging up to about 350 FPM. maximum from the last stand. With the experience gained from rolling at these lower delivery speeds, and by the use of improved mill construction and more refined mechanical and electrical control, higher rolling speeds appear feasible, and tandem mills with roll sizes, gear ratios, and motor speeds selected to provide maximum delivery speeds of 600 FPM. or higher, are being considered.

Mills with maximum delivery speeds of about 250 to 350 FPM., and rolling strip up to 36 inches wide, are being successfully operated with mill motors of from 400 to 500 HP. for each stand, and a reel motor of about 100-150 HP. With the apparent trend toward the installation of mills to roll at higher speeds, the power requirement will increase in nearly direct proportion to the delivery speed, and it will be logical to expect the use of mill motors from 600 to 1000 HP. per stand and a reel motor of probably 200 to 300 HP.

On most tandem cold roll mills, especially those

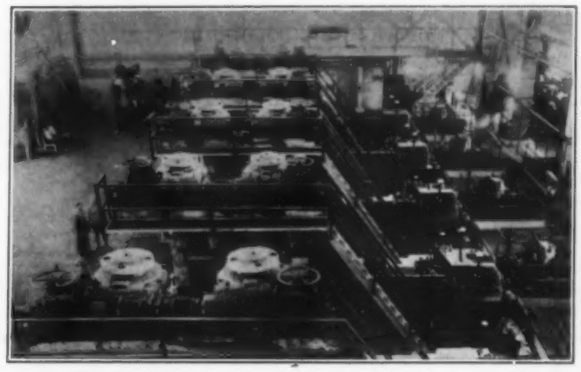


FIG. 3—Installation of 14" and 34" x 58" Tandem Cold Roll Mill, with 600 HP. Driving Motors.

with comparatively high delivery speeds, it is necessary to thread the front end of each strip through the several roll stands and into the winding reel at a speed much lower than the normal rolling speed, and then to quickly accelerate to the desired rolling speed. Also in setting up the mill for each new rolling schedule, it is desirable to be able to make the necessary adjustments while operating at a low speed, and to observe the performance of the mill, and it is quite essential that the mill performance at the normal rolling speed, and during acceleration and deceleration, be the same as observed at the low speed at which the mill adjustments were made. This constant performance is readily attained by the use of suitable variable voltage control, with which the relative speeds of the several mill motors and the reel motor may be adjusted while the motors are operating at a low threading voltage. Then without making any change in the relative speed adjustments, the speeds of all of the motors may be raised by smoothly increasing the generator voltage by means of a motor operated generator field rheostat, thus accelerating the entire mill to the normal rolling speed, and maintaining the adjustments made at the low threading speed. Variable voltage control is essential to the successful performance of any tandem cold roll mill producing wide thin strip, such as for tinplate, and magnetic resistance starting from a constant voltage supply is suitable only for mills

producing comparatively narrow or heavy gauge strip.

Narrow or heavy gauge material may be rolled with the strip slack between stands, as it is sufficiently stiff to allow the use of guides to properly direct it into the rolls. However wide thin strip can-

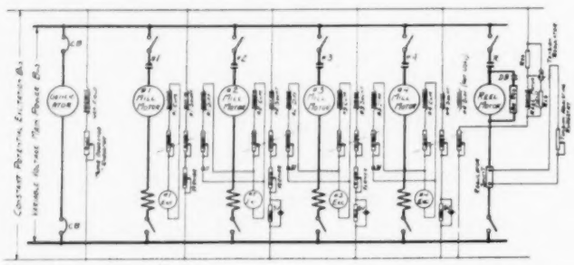


FIG. 4—Connections for Four-Stand Tandem Cold Roll Mill with Interconnected Field Tension Control.

not be held in the correct position by side guides, and the most satisfactory way to hold the strip centered in the rolls is to operate with the strip under tension between stands and between the last stand and the winding reel. A number of methods of electrical control have been devised to provide for operation with controlled tension between the stands of tandem mills, and two of the methods which are in commercial use will now be described.

Figure 4 shows schematically the principal armature and field connections for the drive of a four-stand tandem cold roll strip mill, in which the mill motor fields are interconnected in such a manner as to provide equalization of the loads and compensation of the speeds to maintain the tensions between stands essentially constant with moderate changes in the mill rolling loads due to irregularities in the gauge and hardness of the strip, screwdown adjustments, etc.

Associated with each of the four mill motors, there is provided a small series exciter, driven at constant speed, and excited by the mill motor armature current, so that the exciter voltage is proportional to the mill motor load. Each mill motor is provided with a main shunt field, excited from the constant potential excitation bus, and with two auxiliary series fields, excited from the variable potential series exciters. On each motor, one of the auxiliary series fields is connected cumulatively with respect to the main shunt field, and is excited from its own series exciter, thus compounding the motor and giving it a slightly drooping speed-load characteristic. The other auxiliary series field is connected differentially with respect to the main shunt field and the first series field, and is excited from the next following series exciter. Adjusting rheostats are provided in the main shunt field and in each of the auxiliary series field circuits, and the operating mechanisms of the three rheostats for each motor are mechanically coupled together so that the excitation of all three fields are changed simultaneously to maintain the correct relation of shunt and series excitation at all operating speeds. Vernier rheostats are provided in the main shunt field circuits of all except the last stand motor to permit fine adjustment of the excitation and tension loading.

With the field connections as described above, the excitation of the mill motors may be adjusted so that for any particular rolling condition, the strip will be maintained under tension between successive pairs of roll stands. Analysis will indicate that in case the load on any motor such as say No. 3 should tend to increase, from any cause, the series cumulative excitation will be increased, tending to slow the motor down and reduce its load, and further the series differential excitation of the preceding motor No. 2 will be increased, tending to speed that motor up and thus reduce the tension load on No. 3. Also the slowing down of No. 3 will tend to increase the tension load on the following motor No. 4, but this increased load on No. 4 will tend to slow it down and also speed up No. 3, thus restoring equilibrium, and almost evenly dividing the increased load among the four motors, with only a small change in the tension in the strip.

In threading the front end of a strip through the mill, the series differential excitation must not be applied immediately, else the earlier stand motors will speed up and cause loops to develop between stands. Load relays on mill motors Nos. 3 and 4, and the reel motor are therefore provided, and connected to close contactor 11 when the strip enters stand No. 3, to close contactor 21 when the strip enters stand No. 4, and to close contactor 31 when the strip is brought under tension by the reel.

Occasionally there may be a slight delay in entering the front end of a strip into one or more of the roll stands, so that a considerable length of excess strip may have been delivered from the preceding stand. When such a delay occurs, the excess strip is quickly taken up by momentarily inserting a "speed-up" resistor in the main shunt field circuit of motor Nos. 2, 3 or 4.

Figure 5 shows the schematic diagram of connections for the drive of a four-stand tandem strip mill, and indicates another method which is being used successfully to control the tension between stands. In this arrangement the excitation of each of the mill motors, except No. 1, is regulated by a constant current regulator, acting through a buck and boost exciter. The regulators controlling the excitation of motors Nos. 2, 3 and 4 are set to maintain the current input to these motors at values which will provide an excess of power over the friction and rolling loads to develop tension in the strip between the regulated stand and the preceding stand.

While threading the strip through the successive roll stands at the start of each coil, the current regulators and buck and boost exciters are disconnected from the mill motor field circuits by contactors 21, 31 and 41 being open, and contactors 21-A, 31-A and 41-A being closed. The rheostats in each of the mill motor shunt field circuits are adjusted so that each stand slightly overfeeds the next following stand, thus forming a small loop, and permitting a reading of the mill motor loads without tension between stands to serve as an indication of the settings required on each of the current regulators when the strip is brought under tension. Then as the strip enters each roll stand, that stand motor is brought under the control of its current regulator by connecting the exciter field to the excitation bus, and by opening the shunt around the exciter armature. The combination of the resistance added to the motor shunt field circuits by the opening of contactors 21-A, 31-A and 41-A and the current regulator being

set to maintain the current input to provide power in excess of the friction and rolling loads, causes the regulated mill motors to accelerate slightly to take up the slack and bring the strip under tension between the regulated stand and the next preceding stand.

Figures 4 and 5 also illustrate two general methods of operating the winding reel motor. Where the product of the last stand mill motor speed range by shunt field control and the ratio of the diameter of the largest finished coil to the diameter of the empty reel drum, does not exceed about 3.5, a reel motor with 4:1 speed range by shunt field control may be operated from the same supply voltage as the mill motors, as shown by Figure 4. However reel motors of more than 4:1 shunt field speed range are usually unstable, so that on mills driven by mill motors of wide speed range and rolling long coils causing quite large reel build-up, it is necessary to operate the reel motor from a supply source whose voltage is varied in proportion to the strip delivery speed. This variable voltage supply for the reel motor may be a generator with fixed excitation driven by the last stand mill motor so that its speed and voltage vary in proportion to the strip delivery speed. Or as shown by Figure 5, it may be a separately driven generator, running at constant speed, whose excitation is varied in response to changes in the strip delivery speed to maintain the reel generator voltage proportional to the mill speed. With the reel motor supply voltage varied in proportion to the strip delivery speed, the speed range of the reel motor by shunt field control need be only sufficient to take care of the build-up of the coil on the reel drum.

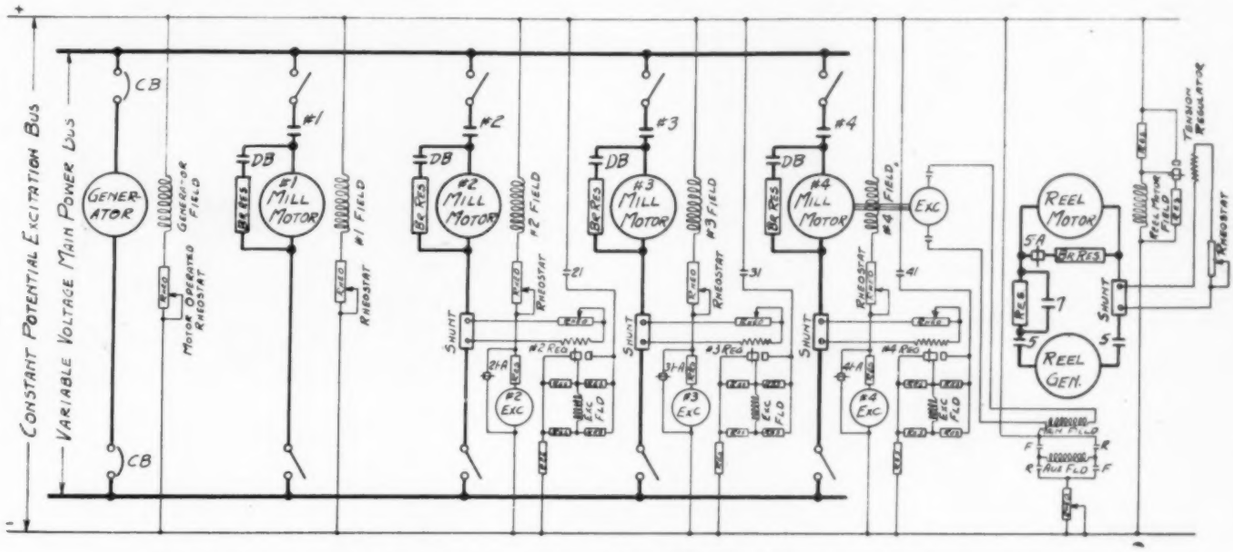


FIG. 5—Connections for Four-Stand Tandem Cold Roll Mill with Current Regulator Tension Control.

reels by a motor of about 500-600 HP. capacity. The reel motors are controlled so that they operate alternately as a motor and as a generator, such that the machine connected to the winding reel on the delivery side of the mill functions as a motor to supply a portion of the rolling power through the tension in the strip and to wind the strip into tight coils, and such that the machine connected to the unwinding reel on the entry side of the mill functions as a regenerative braking generator, driven by the pull of the strip entering the mill, to exert a back tension on the strip. Such back tension is essential to hold the strip tight so it will enter the rolls straight and centered, and also is of advantage in making large reductions and controlling the gauge of the strip. The back tension on the strip entering the mill, and the forward tension on the strip leaving the mill are independently adjustable, and are directly under the roller's control, providing great flexibility, and making this type of mill readily adaptable to the varying operating conditions for different grades of steel and different rolling schedules.

The mill housings, backing rolls, roll neck bearings, screwdown mechanism, and other mill parts, are necessarily of massive size and large capacity, in order to reduce to a minimum the deflection and distortion due to the extremely heavy rolling loads, and thus assure the accurate and uniform gauge of

B—Single Stand Reversible Mills.

A second type of mill which is coming into extensive use for cold rolling thin strip for tinning, as well as for rolling wider heavier gauge sheet material, consists of a single, four-high, roller bearing, mill stand; and two tension reels located one on each side of the mill stand. The general arrangement of a typical mill is shown in Figure 6. The entire equipment is reversible, so that the strip may be unwound from one reel, passed through the mill and rewound on the second reel; the mill rolls are then screwed down and the direction of operation reversed so that the strip is unwound from the second reel, passed back through the mill, and rewound on the first reel; this reversible rolling process being continued for as many passes as may be necessary to effect the desired total reduction. On a 42" mill suitable for producing tinplate stock up to 36" wide, at delivery speeds up to about 1000 FPM. maximum, the mill working rolls are driven by a motor of about 1250-1500 HP capacity, and each of the two

the finished strip. A typical 42 inch mill for rolling 36 inch wide tinplate and similar stock, has hardened forged steel working rolls nominally 16 inches in diameter, cast steel backing rolls 48 inches in diameter, roller bearings of 3 million pounds normal operating load capacity on each of the backing roll necks, a screwdown mechanism capable of screwing down the mill against a total pressure of 5 million pounds, and mill housings with posts 24½x29 inches,

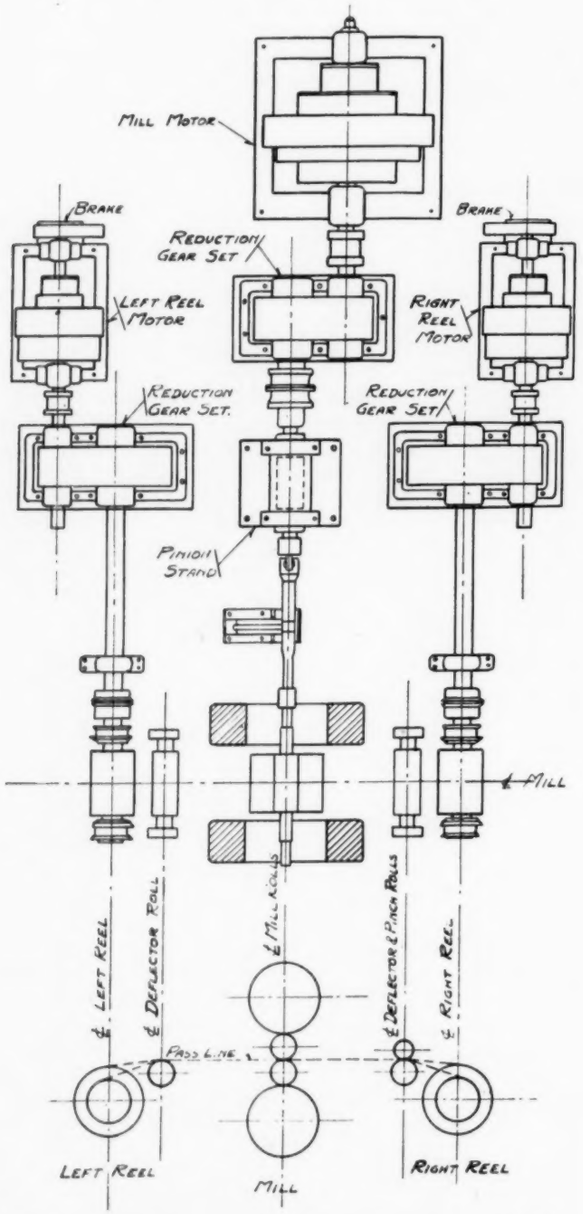


FIG. 6—General Arrangement of Single Stand Reversible Cold Roll Strip Mill and Reels.

or 710 square inches cross section. Two 84 inch mills, now being installed, and designed to produce strip in sheet gauges and up to 76 inches wide, each have working rolls nominally 20 inches in diameter, backing rolls 56 inches in diameter, backing roll neck bearings of 30 inches bore, 51 inches outside diameter and 25½ inches long, having 6 million pounds normal operating load capacity, screws 28 inches in diameter with ½ inch pitch thread driven through a double reduction worm drive of 2000:1 ratio by two 65 HP. mill motors, and mill housings with posts 31x34 inches or 1054 square inches cross

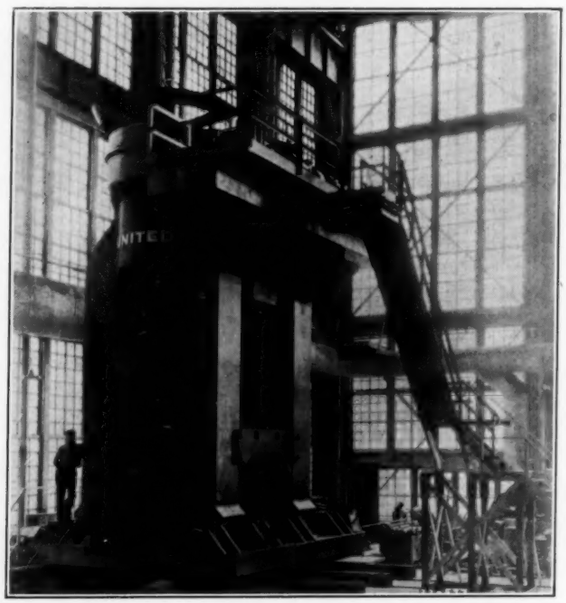


FIG. 7—Shop View of 20½" and 56" x 84" Four-High Cold Roll Mill

section. In May of this year the members of the Association were privileged to inspect one of these 84 inch mills, at the mill builders shop in Salem, Ohio. A view of the other similar mill, in the mill builders shop, is shown in Figure 7.

With the sizes and capacities of the various mill parts indicated in the preceding paragraph, these cold roll mills have ample strength and rigidity to permit making reductions of 50% or more per pass, and the ratings of the electrical equipment to drive the mills which are now in operation or being built, have been selected to permit reductions up to 50%, and in some cases 60%, on the early breakdown passes. Where light gauge hot rolled strip is readily available, .065 inch thick pickled strip is being successfully reduced to .010 inch thick strip for tinning in from three to five passes, depending upon the grade of steel being rolled. It is considered possible to elongate the steel strip 15 or more times without requiring intermediate annealing, and some operators not having facilities to supply 16 gauge or similar light gauge hot strip, may thus be enabled to produce .010 inch thick tinplate stock from hot rolled material about .150-.200 inch thick, in from six to eight passes, at some sacrifice in tonnage output due to the greater amount of cold reduction, and with considerably greater energy consumption, as indicated by the curves of Figure 8. It will be noted from Curve "B" that .065 inch thick hot rolled strip may be reduced to .010 inch thick tinplate stock with a net energy consumption of about 120 horsepower hours per net ton rolled. From Curve "A" it will be noted that it requires

about 85 horsepower hours per net ton to reduce .190 inch thick hot rolled material to .065 inch thick and a further expenditure of about 255 horsepower hours per net ton (or 340 total) to complete the reduction to .010 inch thick finished tinplate stock. Thus in rolling from the thicker hot rolled strip it not only requires the energy necessary to reduce to the gauge at which cold rolling is started with the lighter hot rolled strip, but also the same reduction from .065 inch thick to .010 inch thick requires about twice the energy per ton due to the greater hardness caused by the initial rolling from .190 inch thick to .065 inch thick. Thus both from the standpoint of possible tonnage output rate and unit energy consumption, it appears desirable to begin the cold rolling from fairly light gauge hot rolled strip.

The concentration of all of the cold rolling work in the one roll stand, with independent control of the tension on each side of the mill, gives the roller complete control of the variable factors for different operating conditions, so that he may make the adjustments necessary for successful operation under each combination of conditions. This complete control and flexibility of adjustment permit rolling speeds higher than so far considered feasible for tandem mills. Various 42 inch mills, intended to produce thin strip for tinning, have been laid out for maximum strip rolling speeds ranging from 800 to 1200 FPM.

Figure 9 is a schematic diagram of the principal armature and field connections of the electrical drive for a single stand reversible cold roll strip mill with two reels. It will be readily understood that if the strip thickness is reduced as much as 50% by a single pass through the mill, the speed of the strip entering the mill will be only (100-50)% or 50% of the speed of the strip delivered from the mill, and hence the unwinding reel on the entry side may have to operate down to 50% of the speed of the winding reel on the delivery side, depending upon the reduction being made. In the usual mill layout the speed range of the reel motors by shunt field control is made only sufficient to take care of the range of speed necessary for the winding reel on the delivery side to accommodate the combination of the range of mill working roll diameter, the mill motor speed range, and the range of winding reel coil build-up. For instance, if as shown in detail in Table 1, the mill working rolls may vary in diameter from 15.5 to 16.5 inches, and operate over a speed range of 125/250 RPM. by shunt field control of the mill motor, the total mill delivery speed range will be 507/1079 FPM. Then if the empty reel drums are 30 inches in diameter and the largest coil may build up to 48 inches diameter, the winding reel must operate over a total range of 40/137 RPM. or nearly 3.5:1. Further if the mill may make reductions of from 10 to 50% per pass, the mill entry speed may vary from 50 to 90% of the delivery speed, or 253/972 FPM., and with the same range of coil diameter as on the winding reel, the unwinding reel must operate over a total range of 20/124 RPM. or over 6:1. It is impracticable to build large capacity direct current machines to operate over such a wide speed range by shunt field control, and a booster generator is therefore provided, and connections arranged so that it may be connected in series with either of the reel motors, so that the motor operating as a braking generator on the unwinding reel on the entry side will have to develop only a comparatively low voltage when operating at the minimum speed. At the higher strip delivery speeds, the booster generator voltage is reduced, and the braking generator on the unwinding reel develops practically full bus voltage.

The general method of operation may best be explained by outlining the sequence of operations in rolling a coil. Assume that a coil of hot rolled strip has been placed on the right reel, and that the first pass in thus to be made with the strip being unwound from the right reel and after passing through the mill, being rewound on the left reel. By means of a direction selector switch, circuits are set up to open the R contactors and to close the L contactors, to connect the main generator and booster generator fields for the proper polarity, and to connect the winding tension regulator to control the excitation of the left reel motor and the unwinding tension

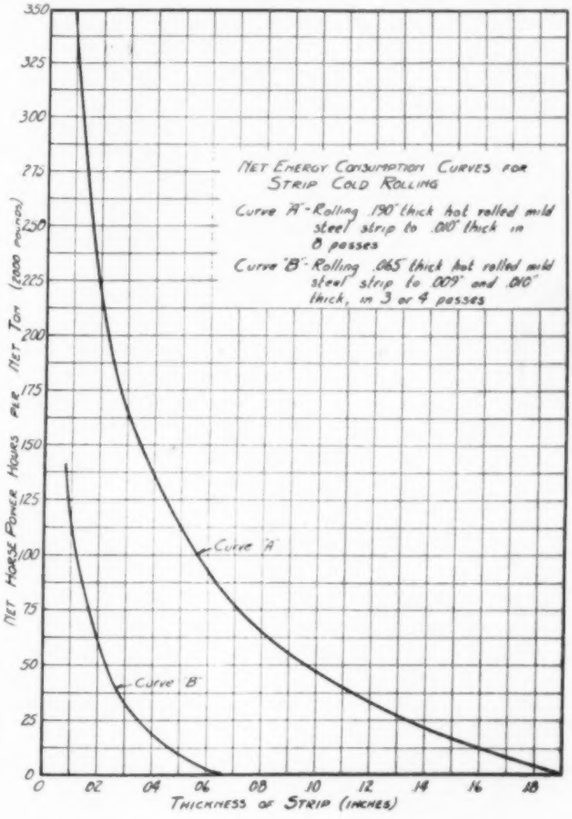


FIG. 8—Energy Consumption for Strip Cold Rolling.

regulator to control the excitation of the right reel motor. It will be noted that the booster generator is provided with an auxiliary field, excited from the constant potential excitation bus, to provide a low voltage for inching and for stalled tension; and a main field, excited from the main bus variable voltage, so that during operation the booster generator voltage will be varied in proportion to the main bus voltage. The end of the strip now may be fed forward into the mill by momentarily closing contactor 8, to connect the right reel motor to the booster

TABLE I

TABULATION OF OPERATING CHARACTERISTICS OF A TYPICAL 42 INCH SINGLE STAND REVERSIBLE MILL WITH TWO REELS

Mill Data:

1. Diameter of Mill Working Rolls	
a. Minimum	15.5 inches
b. Nominal	16.0 inches
c. Maximum	16.5 inches
2. Circumference of Mill Working Rolls	
a. Minimum	4.05 feet
b. Nominal	4.19 feet
c. Maximum	4.31 feet
3. Mill Motor Speed Range by Shunt Field Control	125/250 RPM.
4. Gear Ratio Between Mill Motor and Mill Working Rolls	Direct Connected
5. Mill Working Rolls Speed Range	125/250 RPM.
6. Mill Delivery Speed Range	
a. With Minimum Diameter Rolls	507/1013 FPM.
b. With Nominal Diameter Rolls	525/1049 FPM.
c. With Maximum Diameter Rolls	540/1079 FPM.

Winding Reel Data:

7. Diameter of	
a. Empty Reel Drum	30 inches
b. Largest Finished Coil	48 inches
8. Circumference of	
a. Empty Reel Drum	7.85 feet
b. Largest Finished Coil	12.57 feet
9. Total Mill Delivery Speed Range	507/1079 FPM.
10. Winding Reel Operating Speed	
a. With 48" maximum coil and 507 FPM. minimum mill delivery speed	40.4 RPM.
b. With 30" empty reel drum and 1079 FPM. maximum mill delivery speed	137.3 RPM.
11. Gear Ratio Between Reel Motor and Reel Drum	5.75 to 1
12. Winding Reel Motor Operating Speed Range	232/789 RPM.
13. Winding Reel Rated Tension Capacity, Assuming 600 HP. motor output, and 97% mechanical efficiency	
a. At 525 FPM. Mill Delivery Speed	36,600 pounds
b. At 1050 FPM. Mill Delivery Speed	18,300 pounds

Unwinding Reel Data:

14. Mill Reduction	
a. Maximum	50%
b. Minimum	10%
15. Total Mill Delivery Speed Range	507/1079 FPM.
16. Mill Entering Speed	
a. With 507 FPM. Minimum Delivery Speed and 50% Maximum Reduction	253 FPM.
b. With 1079 FPM. Maximum Delivery Speed and 10% Minimum Reduction	972 FPM.
17. Unwinding Reel Operating Speed	
a. With 48" Maximum Coil and 253 FPM. Minimum Entering Speed	20.1 RPM.
b. With 30" Empty Reel Drum and 972 FPM. Maximum Entering Speed	123.6 RPM.
18. Gear Ratio Between Braking Generator and Reel Drum	5.75 to 1
19. Unwinding Reel Braking Generator Operating Speed Range	115/712 RPM.
20. Braking Generator Voltage at 115 RPM. Minimum Operating Speed	300 Volts
21. Necessary Booster Generator Voltage	300 Volts
22. Unwinding Reel Rated Back Tension Capacity, Assuming 150 KW. 300 Volt Booster Generator Output, 90% Braking Generator Electrical Efficiency, 96% Mechanical Efficiency, 525 FPM. Mill Delivery Speed	
a. With 50% Reduction	29,300 pounds
b. With 40% Reduction	24,400 pounds
c. With 30% Reduction	20,900 pounds
d. With 20% Reduction	18,300 pounds
22A. Unwinding Reel Rated Back Tension Capacity, Assuming 25 KW. 50 Volt Booster Generator Output, 93% Braking Generator Electrical Efficiency, 96% Mechanical Efficiency, 1050 FPM. Mill Delivery Speed	
a. With 40% Reduction	21,600 pounds
b. With 30% Reduction	18,500 pounds
c. With 20% Reduction	18,200 pounds
d. With 10% Reduction	14,400 pounds

23. Ratings of Principal Electrical Machines.
   a. One Mill Motor—1250 HP., 40°C. rise continuous, 600 volts, 125/250 RPM., shunt wound, separately excited, with enclosing rear endbells for forced ventilation, and suitable for normal operation in either direction of rotation.
   b. Two Reel Motors—600 HP., 40°C. rise continuous, 600 volts, 200/800 RPM., shunt wound, separately excited, with enclosing rear endbells for forced ventilation, and with shunt wound magnetic brake mounted on the extensions of the base and shaft, suitable for normal operation as a motor in one direction, and as a braking generator at about half load in the other direction.
   c. Four-unit synchronous motor generator set, consisting of:
      1—1250 KW., 40°C. rise continuous, 600 volt, 720 or 750 RPM., shunt wound, separately excited, main generator.
      1—150 KW., 40°C. rise continuous, 300 volt, shunt wound, separately excited, booster generator, to operate in series with either of the reel motors.
      1—50 KW., 40°C. rise continuous, 250 volt, flat compound, self excited, constant potential exciter generator.
      1—2100 HP. synchronous driving motor.

generator, and momentarily closing the booster generator auxiliary field inching contactors I, to cause the booster generator to develop an inching voltage in the direction to rotate the right reel toward the mill. As soon as the strip has been entered into the mill stalled back tension may be applied by closing contactor 8, and closing the booster generator auxiliary field stalled tension contactors S, to cause the booster generator to develop a low voltage to rotate the right reel away from the mill, and when the slack has been taken up, to circulate a stalled tension current through the right reel motor. The main generator field rheostat is arranged to maintain a low main bus voltage, and the left reel motor may be inched to bring the reel clamp in position to receive the end of the strip, by momentarily closing contactors 3 and 4; and the mill motor may be inched to advance the end of the strip to the left

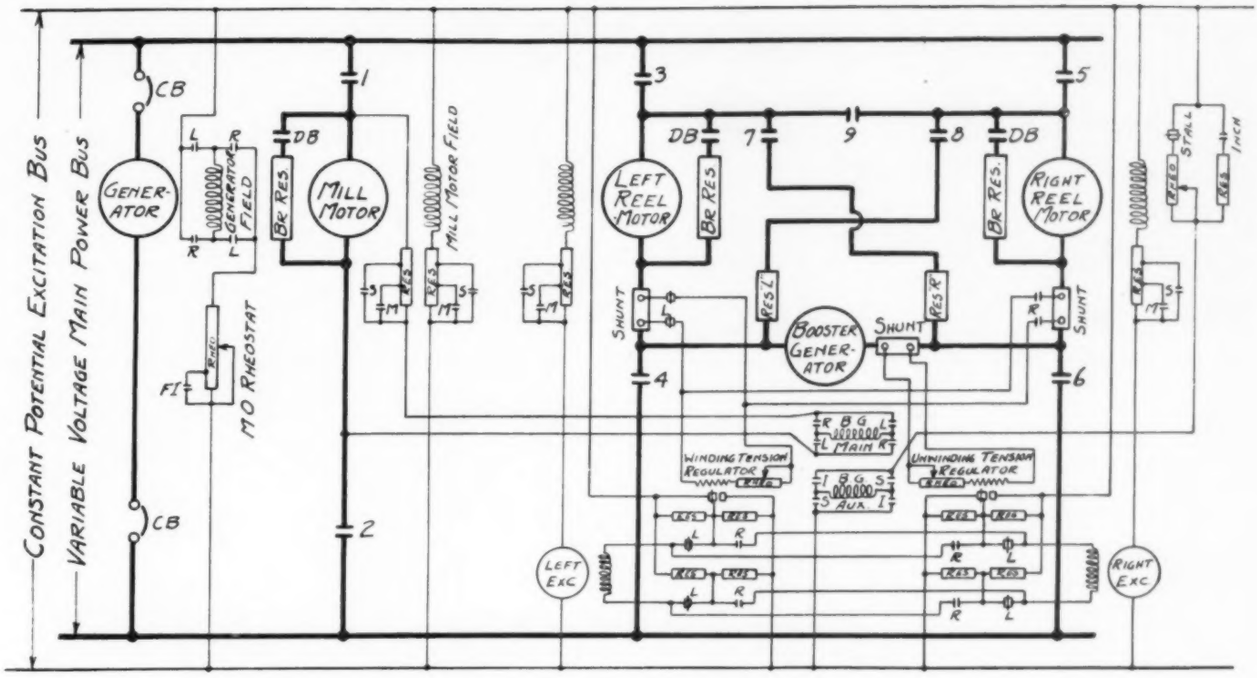


FIG. 9—Connections for Single Stand Cold Roll Strip Mill with Two Reels.

reel, by momentarily closing contactors 1 and 2. As soon as the end of the strip has been clamped in the left reel, the strip may be brought under tension by closing contactor 9 and opening contactor 8. The resistance L is made of the same value as the resistance of the left reel motor armature circuit, so that the same stalled tension current is circulated by the booster generator with stalled tension on either or both sides. The stalled tension may be adjusted by means of the rheostat in the booster generator auxiliary field circuit. The mill drive may now be brought up to speed by closing contactors 1 and 2 to connect the mill motor to the bus, and closing contactors 3 and 4 to connect the left winding reel motor to the bus directly, and the right unwinding reel braking generator to the bus in series with the booster generator, and then raising the bus voltage by the operation of the generator field rheostat. The motor connected to the right unwinding reel is driven by the back tension of the strip entering the mill, and functions as a braking generator. The braking generator voltage is boosted to the same value as the bus voltage by the booster generator, and the back tension braking power is thus returned to the main bus and made available to supply part of the power for the mill and winding reel motors. When the mill is brought to rest by reducing the generator voltage and opening the contactors 1, 2, 3 and 4, contactor 9 is kept closed, and the booster generator auxiliary field excitation is maintained, so that dynamic tension on both sides is maintained at standstill, making it unnecessary to set the magnetic brakes. The direction selector switch is then moved to open the L contactors and close the R contactors, and the mill is started in the opposite direction by closing the mill motor contactors 1 and 2, and the right reel motor contactors 5 and 6. The direction of current flow in the closed regenerative braking circuit is the same for stalled tension and for both directions of operation, hence there is no loss of tension on either side of the mill during the reversal.

The back unwinding tension and front winding tension are controlled by regulating the excitation of the two reel motors to maintain constant current input to the machine operating as a motor driving the winding reel, and to maintain constant current output from the machine operating as a braking generator, driven by the pull on the strip being unwound from the trailing reel. The values of back and front tension may be varied by means of adjusting rheostats in the current regulator coil circuits.

A factor of considerable importance in assuring the successful performance of a single stand reversible mill is the suitable control of the reel motor inertia to avoid breaking the strip. The reel motor ratings are selected to provide tension capacity sufficient to stress the strip up to nearly its elastic limit, during the early passes when the section is large, with the result that the motors are of large physical size and the large armature inertia, unless effectively controlled, may break the strip during the later passes when the cross section and strength of the strip have been greatly reduced. To minimize the bad effects of excessive reel drive inertia, the motors now being applied to drive the reels, are of special design, with armatures of small diameter and long core, to reduce the armature WR^2 to a minimum. Figure 10 is a shop view of the armature of a 600 HP., 600 volt, 250/875 RPM. motor, 32 inches in diameter, 29 inch long core, WR^2 about 7200 pound feet^2. Normally a motor of this rating would be built with an armature 45 inches diameter, 15 inch long core, and WR^2 about 14,200 pound feet^2, indicating that by the special design the inertia was reduced nearly 50%.

Even with reel motors of special design, the reel

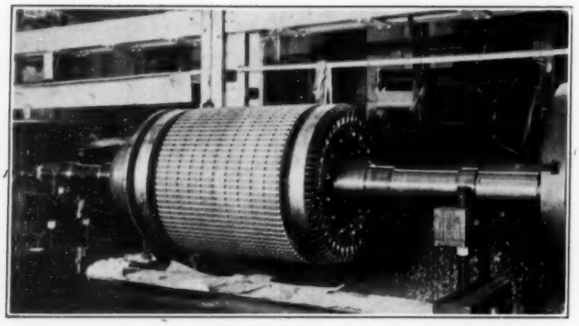


FIG. 10—Armature of 600 HP., 600 volt, 250/875 RPM. Direct Current Motor with Low Inertia for Strip Reel Drive.

drive inertia may still be high enough to necessitate compensation of the current regulator settings to avoid undesirable changes in the strip tension during acceleration and deceleration. For instance, during constant speed operation, the input to the winding reel motor goes to supply the electrical and mechanical friction losses, and to develop tension in the strip. However, during acceleration, a portion of the input goes to accelerate the inertia of the motor armature, and other rotating parts, and if the strip tension is to be maintained constant the input during acceleration must be greater than during constant speed operation. Similarly, during deceleration, the input must be less than during constant speed operation. The amount by which the reel motor input must be increased or decreased depends upon the WR^2 of the parts, and upon the rate of acceleration or deceleration, as determined by the speed of the motor operated generator field rheostat. Figure 11 shows a detail of the connections for a reel motor with provision for changing the reel motor input to compensate for the inertia, and maintain the same strip tension during acceleration and deceleration as when running at constant speed. During constant speed operation, the contactors A-1 and A-2 are closed, and contactors D-1 and D-2 are open, as indicated. These contactors are controlled with the motor operated generator field rheostat, so that when the rheostat is moving to raise the voltage and hence accelerate the mill, contactors A-1 and A-2 are opened to insert resistance in the current regulator coil circuit, and thus raise the setting of the regulator. While the mill is being decelerated by lowering the generator voltage, contactors D-1 and D-2 are closed to lower the regulator setting and reduce the reel motor input.

A similar scheme for compensating for the inertia of the unwinding reel during acceleration and deceleration, may be incorporated in the control of the braking generator, except that in this case the braking generator current output must be reduced during acceleration and increased during deceleration, so that A-1 and A-2 are normally open, and D-1 and D-2 are normally closed.

Figure 11 also shows the use of a bias battery to boost the normal voltage drop in the shunt in the reel motor armature circuit, so that a definite positive voltage will be imposed on the current regulator and the regulator made more stable in its operation, even when regulating for a very low current. Also, when operating at quite low tensions, the amount by which the current input must be reduced during deceleration may be greater than the total input during constant speed operation, or in other words the motor may actually have to be regeneratively braked, and by the use of the bias battery, a positive voltage may be maintained on the regulator even with a negative drop in the operating shunt. Similarly, applied to the regulation of the unwinding reel braking generator, the generator output during acceleration may be reduced to zero or actually reversed so that the generator may operate as a motor to accelerate the unwinding reel.

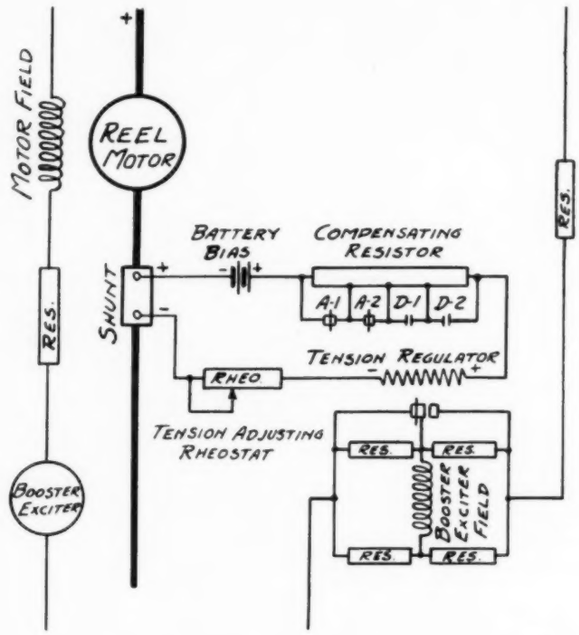


FIG. 11—Detail of Connections for Tension Regulator, showing Arrangement to Compensate for Inertia During Acceleration and Deceleration.

C—Steckel Mills

The third type of cold roll strip mill commonly known as the Steckel Mill, after its inventor Mr. A. P. Steckel, also consists of a single, four-high, roller bearing, reversible roll stand, and two reels located one on each side of the roll stand, so that the strip may be passed back and forth through the single pair of rolls for as many passes as may be required. The Steckel type mill differs from the second type of mill, already discussed in detail, in that the mill rolls are not driven, all of the rolling power being applied to the winding reel on the delivery side of the mill to exert enough tension on the strip to pull it through the die rolls. The amount of reduction per pass is limited by the strength of the strip, so that a greater number of passes are usually required to effect any given total reduction than are necessary on mills where all or part of the power is applied to the rolls. The loss of tonnage output due to the greater number of passes is partially restored by the higher rolling speeds at which the Steckel type mills may be operated, and the spon-

sors of this type of mill also claim that the relatively greater number of lighter reductions result in the more accurate and uniform gauge of the finished strip.

A typical 38 inch Steckel mill, to produce tinplate stock up to 36 inches wide, has small working rolls about 5¼ inches in diameter, and backing-up rolls 34 inches in diameter. With the extremely small working rolls, the roll area in contact with the strip is small, thus reducing the force separating the rolls, and permitting the use of smaller diameter backing-up rolls, smaller capacity roll neck bearings, and mill housings of smaller post section. Since the driving motor is connected to the winding reel, the strip delivery speed for any given motor speed depends on the constantly increasing diameter of the coil on the winding reel. Typical mills are geared to provide a maximum strip speed of about 1250 FPM. when starting on an empty reel drum, gradually increasing to about 1850 FPM. as the coil builds up to its maximum size, however the motor speed is usually controlled to maintain as nearly as possible constant strip speed throughout each pass.

With one or two exceptions, the Steckel mills now installed are driven by a single motor which may be connected to the reel on either side of the mill by means of a double spindle reduction gear and two mechanical clutches. With the left reel clutch disengaged and the right reel clutch engaged, the motor drives the right reel to pull the strip through the mill from left to right and to wind it on the right reel. For the next pass the right reel clutch is disengaged and the left reel clutch is engaged, so that the motor drives the left reel to pull the strip back through the rolls and rewind it on the left reel.

A moderate back tension on the strip entering the mill, is essential to keep the strip centered in the mill, and to prevent cobbles. On the smaller mills, and some of the larger ones also, this back tension is obtained by means of friction brakes. The friction brakes are combined with the mechanical clutches and controlled so that when the clutch is disengaged the brake is set, and when the clutch is engaged the brake is released. Thus the friction brake is automatically set and back tension established on the unwinding reel for either direction of operation.

The use of friction brakes for back tension is open to several objections, the principal ones being listed below:

1. The braking surfaces wear quite rapidly, with costly maintenance, and the brakes must be water cooled, with considerable operating expense.
2. The braking torque is not readily adjustable, and its value cannot be readily indicated.
3. Even though the braking torque remains constant during the rolling of a pass, the strip tension varies inversely with the coil diameter, and hence gradually increases as the coil becomes smaller.
4. Power loss in the friction brakes directly increases the total power demand and energy consumption and thus increases the cost of operation.

These objections to friction brakes have led to the development of a system of electrical regenerative braking for obtaining back tension on the strip entering the mill, and an installation using this system is now being made on a 38 inch mill to produce strip for tinning.

Figure 12 shows the general arrangement of the mill with electrical regenerative brakes, and Figure 13 shows the schematic diagram of the principal electrical connections. The main 1000 HP. motor is arranged with the usual double spindle reduction gear set and two hydraulically operated clutches, so that the motor may be connected to the reel on either side of the mill. In addition there are provided two nominally rated 125 KW. reel drag machines, one coupled solidly to each of the two reels. Connections are arranged so that the machine coupled to the unwinding reel on the entry side of the mill functions as a braking generator driven by the pull of the strip entering the mill, and the machine coupled to the winding reel functions as a motor to absorb the regenerated braking power and to assist the 1000 HP. main motor to drive the winding reel.

A small booster generator, of 15 KW. 25 volt, capacity, is provided in the regenerative braking circuit between the two reel drag generators, to enable independent inching of either reel in threading up the mill, to provide adjjustable stalled tension on both sides of the mill with the mill at standstill and during reversal, and to partially compensate for the resistance drop in the regenerative circuit during operation. Either reel may be inched either toward or away from the mill by momentarily closing contactor 3 or contactor 4 and energizing the booster generator field either forward or reverse. When the end of the strip has been threaded through the mill and clamped in both reels, the strip is brought under stalled tension by closing contactor 2, and exciting

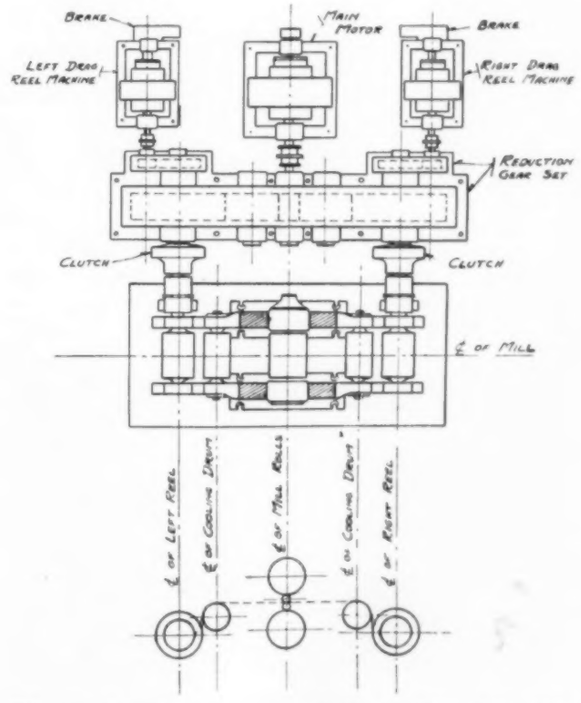


FIG. 12—General Arrangement of Steckel Type Cold Roll Strip Mill with Electrical Regenerative Brakes.

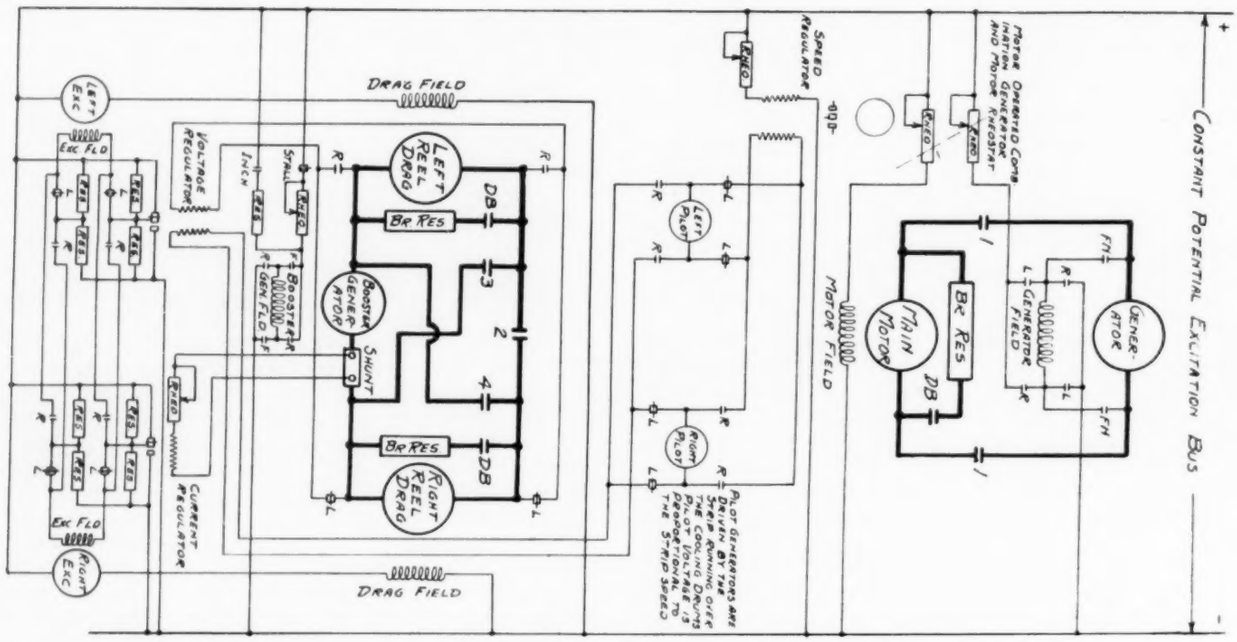


FIG. 13—Connections for Steckel Type Cold Roll Strip Mill with Electrical Regenerative Brakes.

the booster generator to develop a voltage to rotate both reels away from the mill, and when the slack has been taken up, to circulate a stalled tension current. The value of the stalled tension current may be varied by means of the rheostat in the booster generator field circuit.

During the rolling of each pass, the back tension on the strip entering the mill is controlled and maintained essentially constant by the combination of a current regulator and a voltage balance regulator, which act to regulate the excitation of the two reel drag machines. The current regulator is responsive to the current in the regenerative circuit, and for any given setting of the tension adjusting rheostat, acts to control the excitation of the unwinding reel braking generator and maintain constant braking generator current output. The voltage regulator is of the balance type and controls the excitation of the winding reel motor to maintain the regenerative circuit voltage proportional to the voltage of a pilot generator driven by the strip entering the mill. Thus with the current maintained constant and the regenerative circuit voltage maintained proportional to the speed of the strip entering the mill, the braking power is made proportional to the strip speed, with consequent constant back tension, regardless of the rolling speed, mill reduction, or coil diameter on either reel. Also the back tension is a direct function of the current in the regenerative circuit and the ammeter may be calibrated to read in pounds back tension if desired.

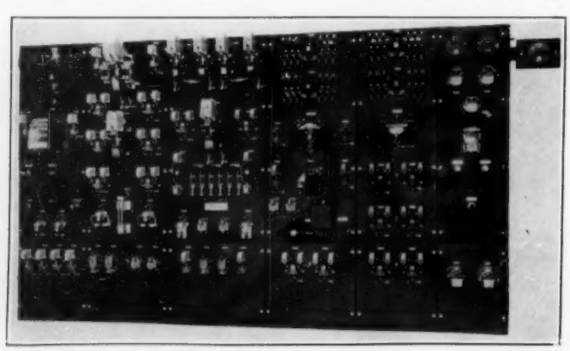


FIG. 14—Special Controller for Steckel Type Cold Roll Strip Mill.

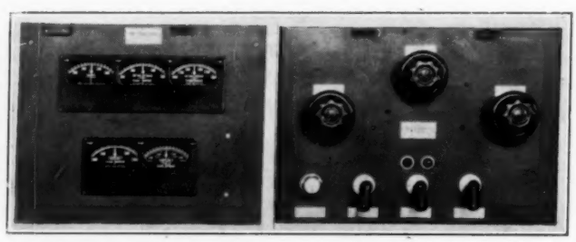


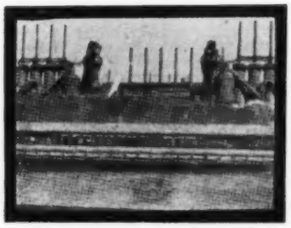
FIG. 15—Pulpit Meter Panel and Pulpit Operators' Panel for Steckel Type Cold Roll Strip Mill.

The control for this particular Steckel mill also includes a special speed balance regulator responsive to the voltage of a pilot generator driven by the strip on the delivery side of the mill, which acts to control the motor operated combination generator and motor rheostat to gradually reduce the motor speed as the winding reel coil diameter increases, and thus maintain the strip delivery speed constant during each pass.

Figure 14 shows the control board for the Steckel type mill with electrical regenerative brakes, and Figure 15 shows the motor panel and the operator's control panel, to be mounted in the operating pulpit to control the various operations and indicate the performance.

Conclusion

In conclusion the author wishes to express his appreciation to the engineers of the various mill builders, and steel plants, who have generously co-operated in the preparation of this paper by offering helpful suggestions and furnishing data and drawings concerning the various types of cold roll strip mills.



The Steel Industry At A Glance

The Iron and Steel Industry is starting to buy. . . . . Inquiries are out for at least seven strip mills of various sizes. . . . . There are two large projects being worked on by the Engineering Departments of two large steel plants. . . . . Both wide strip mills. . . . . Another steel plant contemplates a large boiler house. . . . . Five steel plants are now working on projects to cover electro-plating departments. . . . . A number of steel plants are working on very large capacity direct current homo-polar machines for pipe welding. . . . . One large steel plant is rebuilding an open hearth furnace along new and modern engineering lines which will be of interest to the Steel Industry when operating. . . . . Japan recently placed an order for six hot and six cold mills with a prominent mill builder. . . . . In India on a sheet mill equipped with sheet mill catchers and feeders they rolled 63.45 tons in eight hours. . . . . Hot galvanizing is a live subject in the sheet and tin industry. . . . . Electrical precipitation of blast furnace gas is making progress, inquiries are out. . . . . Electrical manufacturers report improved business for the first quarter. . . . . A mill builder reports developments along abrasive cleaning. . . . . Three high mills equipped with feeders and catchers are making tonnage records. . . . . Gear motors are exciting a lot of interest in the Steel Industry. . . . . Electrically heated annealing and normalizing furnaces are producing quality steel. . . . . Anti-friction bearings will soon enter new fields and applications in the Steel Industry. . . . . Proper lubrication is making progress in the industry. . . . . Automotive manufacturers will find making strip much more of a task than buying it. . . . . New Uses for Steel are being reported daily. . . . . Protective apparatus for electrical equipment in the Steel Industry requires study at the present time. . . . . Air conditioning is and will become more of a problem in the industry. . . . . A prominent eastern steel plant placed an order for $250,000 worth of soaking pit equipment. . . . . Cleaning and Pickling of steels for quality is being given serious consideration. . . . . One large steel plant in the East has installed a cleaning and pickling unit which is modern in every particular and is being operated strictly along engineering and metallurgical lines. . . . . Steel makers are realizing it pays to continue their research studies not only in the open hearths but in the pouring pits and platforms as well. . . . . An appropriation for seven A.C. Welding units has just been granted. . . . . Continuous methods and processes in the Steel Industry means rearrangement of present equipment and huge expenditures for new equipment. . . . . Automotive manufacturers are demanding sheets 84" wide 140" long for bodies. Looks like more wide strip mills. . . . . Requests for appropriations for Primary Gas Cleaners being made up. . . . . One large steel plant plans a large structural shop. . . . . Cold rolling at high speeds for narrow gauges is progressing. . . . . Sheet and tin mills will place requisitions for equipment to modernize their present old style hand mills. . . . . Manufacturers of super-refractories are finding the Steel Industry very receptive particularly in connection with heating furnaces. . . . . Modern material handling apparatus will be in demand in the near future. . . . . Electro copper plating of black plate will find a ready market with oil refineries. . . . . One progressive steel plant manager recently made a complete survey with a large force of engineers and metallurgists of steelmaking, starting with the blast furnaces and continuing through to the finished product, rolling steel in particular was closely observed and followed with excellent results. In this connection the roller, the heater and the working personnel of the rolling mill all co-operated. Results a better grade of Steel.

To The EQUIPMENT BUILDERS WHO SERVICE THE IRON AND STEEL INDUSTRY

In a recent issue of "Printers Ink" they state "the technical staff of any Soviet industrial enterprise originates the requisitions and draws up the specifications needed there."

The above statement is just another instance of the U. S. S. R. following American Iron and Steel Industry practices.

Ninety per cent of all requisitions issued by the American Iron and Steel Industry originates in the engineering and operating departments.

Electrical Superintendents requisition apparatus and material for 7,500,000 HP. in the Iron and Steel Industry.

Mechanical, Combustion, Maintenance and Operating Superintendents requisition materials for 280 Blast Furnaces, 743 Rolling Mills, 1,300 Hand Mills, 1,042 Open Hearth Furnaces, 747 Soaking Pits, 2,000 Heating Furnaces, 1,800 Sheet and Pair Furnaces, 305 Combination Furnaces, 1,400 Box Annealing Furnaces, 40 Butt Mill Furnaces, 11 Seamless Tube Furnaces, 61 Converters, 120 Cupolas and 103 Mixers.

Lubrication engineers requisition $10,000,000 worth of lubricants annually in a year of normal operation.

The readers of the IRON AND STEEL ENGINEER constitute 75% of the engineering executives and operating officials of the Steel Producing Industry who have authority to requisition and specify such material as mentioned above. The IRON AND STEEL ENGINEER caters exclusively to the Iron and Steel Producing Industry.

In the last five years years the IRON AND STEEL ENGINEER printed 623 pages, 195 charts, 134 tables covering all types of Rolling Mills. This information was definite, technical engineering facts, not generalities or abstracts.

In the last five years the IRON AND STEEL ENGINEER printed 471 pages, 109 charts, 66 tables, covering Blast Furnaces, Open Hearth Furnaces and Heating Furnaces. The technical engineering information and data contained in the IRON AND STEEL ENGINEER represents the design, installation, operating and maintenance experiences of equipment used in the Iron and Steel Industry.

As a further service the Statistical Department of the IRON AND STEEL ENGINEER will assist you in making a market survey for your product in the Iron and Steel Industry.

The IRON AND STEEL ENGINEER contains the experiences of more Steel Mill Engineering and Operating Executives in connection with the operation of equipment than any other periodical reaching the Iron and Steel Industry.

Your Sales Messages Will Be Read in The Iron and Steel Engineer

SOAKING PIT, HEATING, ANNEALING AND TUBE FURNACES INSTALLED IN THE IRON AND STEEL INDUSTRY IN THE UNITED STATES, JANUARY 1, 1934

STATES	Firms	Plants	Soaking Pits	Heating Furnaces	Sheet Furnaces	Pair Furnaces	Combination Sheet & Pair Furnaces	Box Annealing Furnaces	Blue Annealing Furnaces	Lap Weld Tube Furnaces (2-per Mill)	Butt Weld Tube Furnaces	Seamless Tube Furnaces
Alabama	6	8	22	35	11	13		15	2			
California	5	7		34	18	18		26	1			
Colorado	1	1	14	11								
Connecticut	2	3	3	5				18				
Delaware	1	1	11									
Georgia	1	1	8	3								
Illinois	18	25	130	95	30	30		40	1		1	
Indiana	12	15	60	126	97	90	44	68	12	12	7	2
Kentucky	4	4	10	6	7	8		17	6			
Maine	1	1		4								
Maryland	5	6	14	24	18	18	65	42	4	4	2	
Massachusetts	2	4	6	6								
Michigan	4	5	13	17	18	22		63	6			
Minnesota	2	2	5	6								
Missouri	5	5		25	2	2			2			
New Jersey	9	11	2	71				3	10			
New York	17	18	35	161	24	16	2	37	58			
Ohio	29	76	163	216	316	329	117	560	102	28	10	3
Oklahoma	1	1		2								
Panama Canal Zone	1	1		2								
Pennsylvania	73	122	241	1029	325	317	48	321	79	44	17	4
Rhode Island	1	1		4					2			
Tennessee	1	1		6								
Texas	1	1		2								
Utah	1	1		2								
Virginia	2	2		21								
Washington	3	3		6								
West Virginia	7	16	10	26	83	83	21	127		4	3	
Wisconsin	5	5		17	10	2	8	12	2			2
Total	220	347	747	1962	959	948	305	1349	287	92	40	11

STEEL PLANT MELTING DATA

State	Companies	Plants	Total Steel Ingot Capacity	Converters	Electric Furnaces	Cupolas	OPEN HEARTHS: Mixers	5-Ton	10-Ton	15-Ton	20-Ton	25-Ton	30-Ton	35-Ton	40-Ton	45-Ton	50-Ton	55-Ton
Alabama	2	3	2,155,000	3	1	3	4			2								
California	6	8	686,000		6			1	1	1	1		5		3	5	3	
Colorado	1	1	898,000			6	5										2	
Connecticut	1	1	120,000														1	
Delaware	1	1	360,000														3	6
Dist. of Columbia	1	1	10,500		1	3												
Georgia	1	1	100,000				11											
Illinois	10	11	8,394,620	8	8	3	8		1			1						
Indiana	5	5	8,187,900	5	1	3	1											
Kentucky	2	2	948,000				4											
Maryland	2	2	1,769,000	3	5					1	1	2		2			1	1
Massachusetts	2	2	234,670		2		5											
Michigan	4	4	1,220,750		8		1											
Minnesota	1	1	540,000										5	6				
Missouri	2	2	325,000										3		10		1	
New Jersey	5	5	319,025	1	12		4						3					
New York	9	10	3,409,790	4	24													
Ohio	13	23	15,806,905	13	9	21	23			1	2	1		5	4			
Oklahoma	1	1	60,000															
Pennsylvania	43	55	23,216,486	22	50	76	36	1		4	10	14	9	13	10	33	68	
Rhode Island	1	1	39,000							3								
Texas	1	1	11,000		1													
Utah	1	1	46,400								1				1			
Virginia	2	2	8,000		3													
Washington	5	5	159,300		5	2										4		
West Virginia	4	4	1,656,640	2	5	3	1							4				
Wisconsin	1	1	575		2													
	127	154	70,681,061	61	143	120	103	2	2	12	15	18	25	30	28	42	79	7

OPEN HEARTHS

State	60-Ton	65-Ton	70-Ton	75-Ton	80-Ton	85-Ton	90-Ton	95-Ton	100-Ton	125-Ton	150-Ton	175-Ton	200-Ton	250-Ton	275-Ton	300-Ton	350-Ton	Total Number
Alabama				6					9		9							26
California		4																24
Colorado			16															16
Connecticut				1														3
Delaware									6									6
Dist. of Columbia																		1
Georgia	3																	3
Illinois	10	6		19		2			17		14		3					80
Indiana				15			28		19	15	7		3	1				90
Kentucky				3		1		2	2	8								16
Maryland										9	6			2				17
Massachusetts	2																	10
Michigan									*7	3	6						1	17
Minnesota				10														10
Missouri									4									15
New Jersey																		14
New York				4	8				22		6		3					46
Ohio	17		3		20	2	28		60	19	9	1						172
Oklahoma									1									1
Pennsylvania	25	28	17	39	53	11		28	58	3	3		10	7		4		448
Rhode Island																		3
Texas																		
Utah																		2
Virginia																		
Washington																		4
West Virginia		2									6			4	1		1	18
Wisconsin																		
	57	40	36	97	81	16	56	30	205	57	66	1	19	14	1	4	2	1042

*Does not include 2-100-Ton Furnaces being Constructed.

ITEMS OF INTEREST

PERSONNEL CHANGES

John Lloyd has been appointed assistant superintendent of the Edgar Thomson works, Carnegie Steel Co., Pittsburgh. He has been with the Carnegie company throughout his entire career.

He first was employed at the company's Carrie furnaces. He began there as a blueprint boy and subsequently was a tracer and draftsman until 1902, when he was transferred to the Mingo Junction, O., works of the company. He went to the works of which he is now assistant superintendent, in July, 1903.

His experience then broadened and after service as a draftsman he became a roller on No. 3 mill, then mill foreman, and in 1923 was promoted to superintendency of the works' rolling mills.

He held that position until his recent appointment as assistant to Frank F. Slick, in charge of the entire steelworks and rolling mills.

▲

C. I. Collins has been appointed superintendent of the Cuyahoga Works of American Steel & Wire Co., Cleveland, succeeding J. T. Leach, who has been transferred to other duties. Mr. Collins formerly was general manager of the Morris & Bailey Division, Pittsburgh, and after that division was absorbed by the American Steel & Wire Co. he had been engaged in special work in Cleveland.

▲

Dana Summers has been elected president of the Chicago Steel & Wire Co., Chicago, succeeding J. B. Green who died April 24, 1933. For a number of years Mr. Summers was general manager of the Wilson Steel Products Co., Chicago, and in 1926 became engaged in automobile sales work. In 1928 he was made superintendent by the Chicago Steel & Wire Co. and early in 1933 he was elected a vice president. Other appointments made by the board of directors are: Loren F. Collins, vice president; A. W. Nelson, secretary-treasurer, and H. E. Johnson, assistant secretary and assistant treasurer.

▲

L. R. Calvert has been appointed Works Engineer of the Westinghouse Lamp Company, according to a recent announcement by H. S. Black, Manager of Manufacturing and Engineering. Mr. Calvert succeeds to the position held by the late E. J. Smith to whom he was an assistant for a number of years.

▲

F. E. Harrell has been made Assistant Chief Engineer of the Reliance Electric & Engineering Company, Cleveland, manufacturers of electric motors.

Mr. Harrell joined the Reliance organization upon graduation from Purdue University in 1924.

Following sales engineering work in Chicago he returned to Cleveland as special engineer for steel-mill motor applications. He has since been Chief Draftsman and Engineer in charge of A-C design.

J. L. Van Nort is now with the Chicago office of the Reliance Electric & Engineering Company as a sales engineer. Previously Mr. Van Nort has represented the Reliance Company in the New England and Cincinnati districts.

▲

The annual stockholders' meeting of Farrel-Birmingham Company, Inc., was held at the main office of the company at Ansonia, Conn., February 15, 1934. The following directors were re-elected: Charles F. Bliss, Henry F. Wanning, Franklin Farrel, Jr., Nelson W. Pickering, Frederick M. Drew, Jr., David R. Bowen, Carl Hitchcock, Franklin R. Hoadley, Armin G. Kessler, Walter Perry, Julius G. Day, Fernley H. Banbury, William B. Marvin, Edward H. Green, William A. Gordon, Alton A. Cheney and George C. Bryant.

Following the stockholders' meeting the Board of Directors met and re-elected the following officers: Franklin Farrel, Jr., Chairman of the Board of Directors; Nelson W. Pickering, President; David R. Bowen, Vice President; Carl Hitchcock, Vice President; Franklin R. Hoadley, Vice President; Armin G. Kessler, Vice President; Frederick M. Drew, Jr., Treasurer; Laurie K. Blackman, Assistant Treasurer; George C. Bryant, Secretary; William B. Marvin, Assistant Secretary.

▲

The Buffalo, New York, district office of the Allis-Chalmers Manufacturing Co., has removed from the Ellicott Square Building to the Liberty Bank Building. Mr. A. D. Brown is District Manager in charge.

▲

D. S. Youngholm has been elected vice president of the Westinghouse Lamp Company, according to a recent announcement by Walter Cary, president of the organization.

Mr. Youngholm joined the Westinghouse Lamp Company twenty-five years ago, immediately after leaving school. His headquarters will be at 30 Rockefeller Plaza, New York, the principal office of the Westinghouse Lamp Company.

▲

Following a recent meeting of the board of directors of the Westinghouse Electric and Manufacturing Company in New York, A. W. Robertson announced the election of A. E. Allen as Vice President. Mr. Allen will have charge of the Merchandising Division which is now established as a separate operation distinct from other divisions of the company. He will have charge of all sales, manufacturing and engineering activities of this new division.

The merchandising division as now constituted will include all products for which the main outlet is through merchandising channels.

▲

Arthur J. Ramsay has been elected Vice President of the Pittsburgh Rolls Corporation of Pittsburgh, Pa., a subsidiary of the Blaw-Knox Company.

Mr. Ramsay has been in the employ of the Pitts-

burgh Rolls Corporation for over twenty-two years, being Sales Manager of this company before his present incumbency.

▲

The Bantam Ball Bearing Company is pleased to announce that Mr. A. S. Hellstrom is now representing them in the Youngstown, Cleveland and Wheeling districts and has been with the company since the beginning of 1934.

Mr. Hellstrom is located at the Ohio Apts., 1625 Ohio Ave., Youngstown, Ohio, and expects to cover accounts in the industrial line, who use ball and roller bearings with particular reference to bearings for steel mills and steel mill equipment.

Mr. Hellstrom has had many years of experience in connection with steel mill equipment, recently returning from Siberia where he assisted in the designing and erection of a modern steel plant, and prior to this time served in various engineering capacities with several concerns who specialize in steel mill equipment.

▲

A. B. Clark has been appointed general traffic manager of the operating companies of Union Carbide and Carbon Corporation, it was announced at the corporation's home office, 30 East Forty-second Street, New York City. Mr. Clark, who is well known in traffic circles throughout the country, succeeds the late Herbert Thompson. He has been with the corporation seventeen years.

▲

WITH THE MANUFACTURERS

A new high voltage, large capacity oil circuit breaker, containing many unusual and new features has been announced by the General Electric Company. Radically different in design, each single-pole unit of the new breaker is shaped like a cross in contrast to the tanklike construction of conventional equipment. Higher breaking speeds with short arcing times and the use of very little oil are among the distinct advantages offered by the new equipment. Only 96 gallons of oil per pole are required by a breaker with an interrupting rating of 1,500,000 kva. at 138 kv. compared with approximately 1700 gallons per pole for a conventional breaker of an equivalent interrupting rating.

Horizontal containers, not much larger than conventional bushings, enclose the interrupting mechanisms. These containers are mounted on vertical central supports which, in addition to serving in an insulating capacity, also house current transformers when such equipment is required. The operating mechanism is located in the base of each single-pole unit and an insulated operating rod passes up through the central support to the container. The interrupting elements consist of several sets of contacts in a line and the inside of each container is so arranged that oil, driven by a piston, is positively directed across the arc path of each of the several arc breaks per pole during circuit interruption.

▲

The Poole Foundry and Machine Company, Baltimore, Maryland, are distributing to the trade a new 302-page catalog of machine moulded gears, listing approximately 10,000 different sizes, kinds and types of gears. These gears range in size from 3" diameter to 15 ft., weighing from 5 pounds to 70,000 pounds. This catalog is being distributed gratis to interested parties.

▲

The Edwin L. Wiegand Company, Pittsburgh, are now distributing the new Chromalox Heating Unit Catalog 34. This very complete heating equipment catalog contains 56 pages and is planned and arranged to help the reader find instantly the detailed information needed to apply heat electrically. Installation instructions, suggestions and drawings are included. Tables and charts are incorporated to aid in the selection of the type, size and rating of heaters. Copy of the catalog may be obtained by writing the Wiegand Company.

▲

"Bracket Bearing Synchronous Motors" is the title of the new Bulletin 1165 which is being distributed by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. This Bulletin contains engineering information and construction features of the motors. Information on motors with special features of construction and data on control equipment are incorporated. Interested parties may secure this well illustrated 16 page bulletin by writing the above concern.

▲

The New Departure Manufacturing Company, Bristol, Conn., have prepared the ninth edition of the "New Departure Ball Bearing Catalog." This very attractive and useful 128 page catalog contains new bearing types; new list prices and additional sizes of existing types. Other features which make it of unusual merit include sections on: Bearing Design and Load Characteristics—Typical Mounting Designs—Factors for the selection of bearings at Electric Motor Speeds—Factors for selecting bearings for speeds down to 10 R.P.M.—Fits and Weights for all Bearings—Telegraphic Code. Copy of this new catalog may be obtained by writing the New Departure Manufacturing Company at Bristol, Conn.

▲

The Thompson Electric Company, 1101 Power Ave., N. E., Cleveland, Ohio, have prepared a folder on their Heavy Duty Lamp Shock Absorber or Vibration Arrester. Installation information and performance records are incorporated in this interesting folder. Copy may be obtained by writing the above concern.

▲

The Poole Foundry & Machine Company, Baltimore, Md., are distributing their new catalog 34 on Flexible Couplings. This catalog supersedes all previous issues and embodies engineering data, tables and information on couplings of their manufacture. This 72 page catalog contains many photographs and drawings and will be sent to interested parties on request.

▲

The Reliance Electric and Engineering Company, Cleveland, Ohio, have recently added single-reduction units to their line of gearmotors. They are used for

ratios up to 6:1 inclusive. They can be furnished with both a-c and d-c motors of various types in sizes rated ¾ hp. and up. Multi-speed and adjustable-speed motors may be used.

The entire reduction is obtained in a single pair of gears. Substantial feet, cast integral with the gear housing, afford a solid support close to the point of maximum torque application. Ball-bearings are used throughout.

Motor parts, and gears may be readily removed and assembled.

Some advantages of these combined units are lower first-cost, reduced space, lower installation and maintenance expense.

▲

The Trumbull Electric Mfg. Co. announces a New Ready Reference Catalog 16-A, listing switches and panelboards.

The condensed style of listing is a revolutionary one and has been arranged in tabular form to facilitate price and feature comparisons of the various types of Trumbull Switches which have corresponding ratings.

The purchaser, under this method, may review at a glance, on one page all the switches in one line and ascertain immediately all switches available for any given rating and classification.

Brief descriptions and illustrations cover each type of product.

It is believed this condensed form will meet with universal trade approval. Copy sent on request.

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"Norma-Hoffman Ball and Roller Bearing Pillow Blocks" is the title of a new bulletin, No. 934-A, just issued by Norma-Hoffmann Bearings Corporation, Stamford, Conn. The many items illustrated and described by complete specifications, are equipped with various types of self-aligning "Precision" bearings of either ball or roller type. A complete range of 2-bolt and 4-bolt pillow blocks, with bearings, is presented—together with several series of take-up mountings, machine mountings, and flange mountings (all with "Precision" bearings) adapted for various machine assemblies. Shaft sizes range, in the several types, from 11/16-inch to 8-inch diameter. Load ratings and mounting instructions supplement the specification data. Copy may be secured on request.

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The Ohio Electric Mfg. Co., of Cleveland, Ohio, have brought out The New Ohio Lifting Magnet Controller.

This controller retains all of the good features of Ohio Magnet Control such as a choice of Lever or Push Button Master, Magnetic Switch Reverse for quick drop of load and the indestructible Lavite Arc Shields.

Using the Lever type master the operator throws Forward for Lift and Back for Drop. The Push Button Master is somewhat smaller and with it the operator presses Left button for Lift and Right button for Drop; two moves only, in either case, and there is no way by which he can do anything wrong that would hurt the Master or the Controller or the Magnet.

The outstanding feature of the new controller that makes it new in a way that will be continuously valuable to operators lies in the use of the Ohio Arc Suppressor built into the controller in place of the former resistance units to take and absorb the big kick voltage developed when the magnet circuit is opened.

This controller would usually be sold and used with steel cover but same can easily be completely removed and left off if desired. All the parts of the control are strong and husky and because of the Arc Suppressor there is very little contact tip wear. Literature may be obtained on the controller by writing the above company.

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OBITUARIES

John C. L. Ward, one of the founders of the Stimple and Ward Company, Pittsburgh, Pa., died on Wednesday, February 21. Mr. Ward was well known throughout the Iron and Steel and Allied Industries and he had a host of friends among the engineering executives and operating officials.

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Walter D'Arcy Ryan, General Electric illuminating engineer, universally regarded as the man who first made artificial illumination both a science and an art, died at his home in Schenectady, March 14. He was first stricken last summer while occupied at the Century of Progress Exposition at Chicago as director of lighting.

Since June 13, 1932, Mr. Ryan had been a consulting engineer of the General Electric Company, and his work was devoted to that of a consultant for the illuminating engineering laboratory.

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Thomas Parrock, 81, former superintendent of the Republic Iron & Steel Co. in the Youngstown, O., district, and first president of the Youngstown Foundry & Machine Co., died in that city, February 20.

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John H. Sennett, superintendent of the welded tube department at the Aliquippa, Pa., works, Jones & Laughlin Steel Corpn., died on February 15. He had been identified with the Jones & Laughlin Company since 1915.

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Col. Elbert A. Gibbs, vice president in charge of operations of McClintic-Marshall Corpn., a subsidiary of the Bethlehem Steel Co., died in Aiken, S. C., on March 6.

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Frank R. Dravo, chairman of the board of the Dravo Corpn., Pittsburgh, and president of the Dravo Contracting Co., was killed in a train wreck at Pittsburgh on February 26. He was graduated from Lehigh University, Bethlehem, Pa., in 1887. In 1891 he organized the Dravo company, and had been actively identified with it during his entire business career.

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Frank W. Kennedy, Vice President and General Manager of the De Laval Steam Turbine Company, Trenton, New Jersey, died at his home at Yardley, Pennsylvania, on January 24th, 1934, after a short illness.